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CANADIAN ARMY
MANUAL OF TRAINING

ARTILLERY TRAINING

RADAR CDX No. 2 MK 1

OPERATING INSTRUCTIONS AND DRILL

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C36
no. 4-15-9
CWM
1956

ABBREVIATIONS

The following abbreviations are used in this pamphlet:—

cm	Centimeter
CR	Control room
db	Decibel
F Comd	Fire Commander
GEOREF	Geographic reference
KV	Kilovolts
KVA	Kilovolt amperes
ma	Milliamperes
OP	Observation Post
OPO	Observation Post Officer
PE	Permanent Echo
PO	Plotting Officer
PUSS	Presentation Unit Shell Splash
QE	Quadrant Elevation
SDHQ	Seaward Defence Headquarters
TA	Technical Assistant
VR	Voltage Regulator

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CHAPTER 1

GENERAL

SECTION 1: BRIEF DESCRIPTION OF CDX No 2 MK 1

1. *(a)* The CDX is designed as a range finding and splash-spotting fire control instrument. A displacement converter is incorporated in the CDX, to correct for the displacement of this radar from the battery pivot.

(b) The CDX is capable of delivering the following information via magslip transmission (ref. diagram No. 1).

(i) Gun (i.e. battery pivot) range, accurate to within 25 yards to any target detected in its arc of sweep, and between the limits of five times the distance from CDX to battery pivot as minimum and 37,000 yards as maximum.

(ii) Radar or gun-bearing as obtained by CDX or by 17A director, accurate to within 10 minutes to any target detected within the limits outlined in (i) above.

(c) Discrimination of two or more targets is limited by CDX beam width and pulse width. If two or more targets, at the same range, are within 3 degrees bearing of each other, or when on the same bearings are within 200 yards of each other, the echoes will merge and bearing accuracy is slightly lessened.

(d) In addition, the CDX is capable of supplying fall of shot data, displayed on the gridded screen of the PUSS, for the information of the OPO.

(e) Shell-splash measurements as from the CDX position, in degrees and minutes right or left and in yards plus or minus, provided the shell-splash as observed from the CDX, is within approximately 2½ degrees bearing and 1,000 yards range of the target being engaged. However, when the shell-splash is within 200 yards of the target, as from the CDX the bearing spotting can only be given as right or left. Range spotting for shell-splash from 0 to 200 yards can be given to an accuracy of 50 yards. This observation will require more skill on the part of the range operator because the target and splash echoes will be merged.

(f) Radar range and radar bearing, with the same accuracy is in *(b)* (i) and (ii) above, to any target within the limits of range of five times the displacement of the CDX to battery pivot and approximately 800 yards (as measured from the CDX position) and within the arc of the sweep of the CDX.

e.g. Displacement, CDX to battery pivot equals 500 yards. Five times displacement CDX to battery pivot 5 x 500 equals 2,500 yards.

Normal interference due to land echoes equal 800 yards, therefore radar range and radar bearing may be supplied from 800 to 2,500 yards. Range being measured from CDX position and within the arc of sweep of the CDX.

Information transmitted by telephone

2. Approximate range and bearing to any target at ranges exceeding 37,000 yards and within the CDX arc of sweep up to the maximum pick-up range, which depends upon the site of the CDX, will be transmitted by telephone.

Equipment

3. *(a)* A tower assembly consisting of a transmitting and a receiving antenna system, transmitting equipment, rotation motors and turntable.

(b) Rack assembly consisting of three racks, interconnected by leads and co-axial cables.

(i) Rack No. 1 contains the measuring system, displacement converter and DC power supplies.

(ii) Rack No. 2 contains the main receiver and display units.

(iii) Rack No. 3 contains the bearing control and measurement systems and transmitter.

(c) A gasoline run engine generator which supplies power (7·5 KVA at 115 volts and 60 cycles) for the operation of the equipment (when civilian or battery engine room power is not available.)

(d) A remote control panel on which are mounted controls for the operation of the engine generator. Provision is made to operate the radar from either the engine generator or from the civilian supply of power whenever the latter is available.

Range and Bearing Rates of CDX No. 2 Mk 1.

4. The CDX No. 2 Mk. 1 is capable of attaining maximum and minimum slueing and tracking rates as follows:—

Maximum bearing slueing — 250 degrees per minute
Maximum bearing tracking— 100 degrees per minute
Minimum bearing tracking— 1 degree per minute
Fast range slueing —120,000 yards per minute
Slow range slueing — 2,000 yards per minute
Maximum range tracking — 2,000 yards per minute
Minimum range tracking — 60 yards per minute

SECTION 2: ROLES OF CDX No. 2 MK 1.

Primary role

5. *(a)* The primary role of the CDX No. 2 Mk. 1 is that of a short range fire control instrument, designed specifically to fight one target until such target is destroyed or a fresh target is ordered. In this role it is known as the fire control radar.

(*b*) The following information is capable of being passed by the CDX to the battery:—

Information	*Destination*	*Method*
Bearing to target	Gun	Magslip
Range to target	Gun	Magslip
Bearing and range travel rates	OP	Telephone
Target courses and speed	OP	Telephone
Estimation of target size	OP	Telephone
Fall-of-shot observations	OP	Telephone or PUSS

(*c*) Normally bearing and range to target will be passed direct to guns via magslip transmission, while target course and speed, fall-of-shot observations and estimation of target size may be passed to the OP.

Secondary role

6. (*a*) The CDX No. 2 Mk. 1 may be used in a secondary role of tactical control radar. The CDX will only be used in this role when coast watching tactical control radar sets in the area are off the air for maintenance and/or repairs, or at the direction of the F Comd.

(*b*) When used in this role, all information on shipping which is plotted by the CDX will be passed to SDHQ by telephone in GEOREF terms.

SECTION 3: CONTROLS OF CDX No. 2 MK.1

7. The following is an outline of the various controls, meters, switches etc., available on a CDX with a brief description of the function of each.

RACK NO. 1 (FIG 1)

Panel 1

8. (*a*) *Telephone binding posts*—these connect to a similar set of binding posts on the side of the tower, and are also in parallel with a second set of binding posts on the right side of rack No. 1, about 24 inches above the floor. The telephone to the tower rests in a tray on the left side of rack No. 3 and is permanently connected to the lower binding posts on rack No. 1.

(*b*) *Rack light switch*—used to control the rack lighting in rack No. 1.

(*c*) *Room light switch*—controls the indirect light on the top of rack No. 1.

(*d*) *Converter orient check*: *push button*:—this control is used to ensure that the bearing information fed to the battery is correct. The operator will use this button each time the magslip is turned on. This button should be depressed after the magslip power has been turned on, while the tower bearing is altered by at least 10 degrees, and the button then released.

(*e*) *Current and voltage meters*—used for metering circuits.

(*f*) *Battery magslip indicator lights*—indicate when battery magslip power is on for bearing and range.

(*g*) *Voltage and current metering switches*—used in conjunction with meters in (*e*) above for metering circuits.

Panel 2

9. (*a*) *Tracking stop, push button*—depressing this button stops the range tracking motor, and when released the tracking motor will resume its former speed.

(*b*) *Radar magslip indicator lights*—the left light glows when the magslips are energized. The right light glows only when the CDX is transmitting magslip data. When the gun range has been decreased beyond the minimum limit of the converter, the right light goes out. The magslip pointers then go to battery magslip datum.

(*c*) *Magslip power switch*—energizes the CDX magslip from the CDX source. This will normally remain in the ON position.

(*d*) *Dial lights*—this knob controls the illumination of the converter dial lights.

(*e*) *Bearing main and vernier dials*—these indicate the radar bearing of the target as set into the converter. They should not be used to obtain the accurate radar bearing of a target since they are mechanically driven by the converter and have a slight tendency to hunt.

(*f*) *Range main and vernier dials*—these indicate the accurate radar range of the target.

(*g*) *Range rate dial*—shows the rate of increase or decrease of range of target in yards per second. (locally calibrated in yards per minute.)

(*h*) *Dial light*—This knob controls the illumination of the range rate dial.

(*j*) *Range tracking handwheel*—operates the range tracking motors to track a target for range.

(*k*) *Slow range slueing switch*—used to alter the range setting more rapidly than the tracking handwheel.

(*l*) *Fast range slueing switch*—used to alter the range setting more rapidly than the tracking handwheel or slow range slueing switch.

RACK No. 2 (FIG 1)

Panel 1

10. (*a*) *Metering 3 switch*—used to meter currents in main receiver chassis when the DC current switch is in position 3.

(*b*) *Gain knob*—controls 15 KV potentiometer which varies screen potential on first two stages in bearing channel of main receiver.

(*c*) *Auto gain control*—controls the setting of the video in the bearing channel of the main receiver.

Panel 2

11. (*a*) *Crystal current meter*—This meter should not read in excess of 0·7 ma.

(*b*) *Oscillator current meter*—This meter should not read in excess of 7 ma when the set is in operation and should be checked periodically by 2 during action.

(*c*) *Oscillator current adjust*—normally this will not be used by the operator although it may be necessary for 2 to alter the setting slightly to increase signal amplitude.

(*d*) *Oscillator frequency control*—this is altered by the operator to provide maximum signal strength. The lights at either side of the switch indicate that the control has reached an end of its run.

Panel 3

12. *General controls*

(*a*) *Bearing slueing* 2 *switch*—When the bearing control selector on rack No. 3, has been placed at the slueing 2 position, this switch will control the slueing direction of the doghouse. This will be used during routine searchings.

(*b*) *Slueing rate control* 2—This knob is used in conjunction with the bearing slueing 2 switch. It controls the bearing slueing speed.

(*c*) *Output selector* –1–2–3 *switch*—selects for display on CRT's 1 range video output, 2 bearing channel output, 3 calibration pips. This switch will be placed in position 1 during operation of the set and in position 3 when checking calibration.

(*d*) *Main gain control*—used to alter the amplitude of the pattern on both the No. 1 and No. 2 CRTs. The No. 2 operator will adjust the setting of the knob to provide a target of sufficient amplitude to permit good range tracking. Gain dial will be calibrated in decibels on the site.

1 *CRT Controls*

(*e*) *Horizontal shift control.*—is used to shift the No. 1 sweep from side to side on the face of the CRT. This will be adjusted until the sweep is centered on the CRT.

(*f*) *Vertical shift control*—used to shift the No. 1 sweep up and down the face of the CRT. This will be adjusted to bring the sweep near the bottom of the CRT.

(*g*) *Brill control*—used to alter the brilliance of the pattern on the No. 1 CRT and is adjusted to give a sufficiently bright pattern.

(*h*) *Focus control*—altered to provide a clear, distinct pattern on the No. 1. CRT.

(*j*) *No.* 1 *CRT*—the sweep on this tube displays 40,000 yards of target range normally, but may be set up to display ranges up to approximately 80,000 yards if required. It is used for routine searching for targets, and to position the target approximately in range. (diagram No. 1.)

2 *CRT Controls*

(*k*) *Spotting switch*—this switch is normally in the OFF position. When the shell splash errors are to be measured, the operator depresses this switch to the ON position.

(*l*) *No.* 2 *CRT*—displays any selected 2,000 yards position of range up to 37,000 yards. To follow a target accurately, the operator keeps the leading or left hand edges of the target echo and the operate marker on the sweep, coincident.

(m) Horizontal shift control—used to shift the No. 2 sweep from side to side on the face of the CRT. This will be adjusted to bring the left hand edge of the operate marker coincident with zero scale graduation before range error is read when observing fall-of-shot.

(n) Vertical shift control—used to move the No. 2. sweep up and down the face of the CRT. This will be adjusted to bring the sweep in line with the range scale.

(o) Brill control—used to alter the brilliance of the pattern on the No. 2. CRT and is adjusted to give a sufficiently brilliant pattern.

(p) Focus control—altered to provide a clear distinct pattern on the No. 2. CRT.

(q) Range error control—when the spotting switch is placed at the ON position, and knob is turned, the error marker can be placed under the shell splash.

RACK NO. 3 (FIG 2.)

Panel 1.

13. *(a) Over voltage light*—when lit indicates that the over voltage relay has removed the input power to the radar circuits.

(b) Thyratron heat light—indicates that the thyratron heaters are off.

(c) Lights indicating closed contactor—

(i) *High voltage light*—this glows after both the 45 and 55 second delay relays have closed when both the power and high voltage switches have been thrown to the ON position.

(ii) *Power light*—this glows 45 seconds after the power switch has been thrown to the ON position. It indicates that the 45 second delay contractor has closed.

(d) Main breakers—Radar load—Auxiliary load—115 volts AC is supplied to the equipment through these switches. Both breakers must be closed before the radar equipment will operate. The auxiliary breaker controls all outlets, heaters and the coils of the power relays.

(e) Line voltage meter—indicates the voltage of the line power supplied to the set.

(f) Line frequency meter—indicates line frequency and should read 60 cycles.

(g) Operation time meter—indicates the number of hours that the set has been in operation.

(h) High voltage switch—controls input to 45 seconds delay and 55 seconds delay high voltage circuit. This switch is normally not thrown to the ON position until the power light glows.

(j) Power switch—controls input to instantaneous and 45 second delay low voltage circuits.

Panel 2

14. (*a*) *Magnet current meter*—when the set is operating this meter should read approximately 150 ma.

(*b*) *Average pulse current meter*—the transmitter control variac should be used to increase the high voltage until this meter reads approximately 20 ma.

(*c*) *Transmitter power supply voltmeter and ammeter.*—the transmitter control variac should be turned clockwise until these two read approximately 15 KV and 20 ma respectively.

(*d*) *Magnet current control*—this control should be turned clockwise until the magnet reads approximately 150 ma.

(*e*) *Transmitter control variac.*—this control should be turned in a clockwise direction until the transmitter power supply voltmeter reads 15 KV and the average pulse current meter reads 20 ma. This control is turned in the extreme counterclockwise direction when the set is being turned off and is not turned clockwise again until the high voltage light glows.

Note: The values of magnet current, pulse current and high tension voltage quoted above approximate the actual setting required but must not be taken as fixed values since all equipments will not necessarily require the same settings.

The optimum settings for magnet current, pulse current and transmitter power supply will be determined for each equipment by the radar mechanic on site and these values posted in a conspicuous place for the guidance of the operating personnel.

Panel 3

15. (*a*) *Bearing control selector*—determines which set of bearing controls will be able to alter the bearing of the tower.

(*b*) *Bearing rate meter*—graduated in degrees per minute, and indicates the approximate bearing rate of the tower, when the tracking controls are being used.

(*c*) *Bearing error control*—used to re-center the bearing meter when Radar 2 has placed the error marker under a shell splash echo.

(*d*) *Bearing meter*—track a target in bearing, the operator keeps the needle of this meter centered.

(*e*) *Bearing rate vernier*—used to multiply bearing rate deflection by 10, is depressed when slow rates are to be estimated.

(*f*) *Bearing slueing* 1 *switch*—used to control direction of bearing slueing when the bearing control selector switch is placed at the slueing 1 position.

(*g*) *Bearing slueing* 1 *rate control*—used in conjunction with the bearing slueing 1 switch to control the bearing slueing speed.

(*h*) *Bearing tracking controls*—(Bearing aided-laying gearbox)

(i) *Bearing control switch*—this switch must be in the ON position in order to use any of the bearing controls.

(ii) *Amber light*—glows when the bearing rate control is at zero.

(iii) *Bearing corrector handwheel*—used to provide aided laying or positional laying.

(iv) *Bearing rate control with locking device*—controls the bearing tracking rate. Provided with a locking device to lock control in any position.

(*j*) *Intergrator controls—(inside panel door)*

(i) centering—operate switch used when centering bearing meter needle.

(ii) bearing centering control—used to center bearing meter needle when centering-operate switch is at centering.

(*k*) *Hunter magslip main vernier switch*—a two position locking switch with a center position, it selects either main or vernier outputs of tower magslips and of the No. 17A director. For checking accuracy of bearing data.

Bearing magslip test boxes

16. (*a*) Range: shows gun range output of displacement converter.

(*b*) Bearing shows:

(i) gun bearing output of displacement converter or

(ii) radar bearing output of doghouse when gun bearing/radar bearing switch is depressed.

Auxiliary power unit remote control panel—front (Fig. 3)

17. (*a*) Ammeter—indicates the current supplied by the auxiliary power unit.

(*b*) *Voltmeter*—indicates the voltage supplied by the auxiliary power unit.

(*c*) *Ignition, oil and coolant failure signal light (warning light)*—The red light is on when the ignition switch is ON and the engine not running.

(*d*) *Damper control switch*—when ON the dampers will operate if the auxiliary power unit is running or line power is available at the control panel.

(*e*) *Starter button*—with the ignition switch ON, pushing this button will start the engine and cause the warning light to go out.

(*f*) *Battery charging switch*—when ON, the battery charger will charge the auxiliary power unit battery, if the panel is connected to an external source of 115 volts AC.

(*g*) *Ignition switch*—when this switch is ON, it energizes the warning light and renders start buttons on remote control panel and auxiliary power unit panel operative.

(*h*) *Voltage adjust rheostat*—adjusts output voltage to be automatically regulated by voltage regulator. It is used only when voltage regulator switch is ON.

(*j*) *Polarity reverse switch (unlabeled)*—may either be up or down during operation. The purpose of this switch is to reverse the current flowing through the contacts. If current flows in one direction for a long time, material is transferred from one contact to the other, resulting in pitting and burning.

(*k*) *Pilot light*—glows when the voltage regulator switch is ON.

(*l*) *Voltage regulator switch*—when ON, voltage is automatically regulated after being set at the required value by the voltage adjusting rheostat.

(*m*) *Load circuit breaker*—is the main breaker between the terminals of the generator and the load. It automatically breaks an overload.

(*n*) *Excitor field rheostat*—with the voltage regulator switch in the OFF position the generator voltage can be controlled manually by the excitor rheostat.

Auxiliary power unit control panel (engine room)

18. These controls on this panel are to facilitate maintenance and repair.

Warning light—glows when the safety switch is OFF, indicating the start switches on the remote control panel and the auxiliary power unit panel are de-energized.

(*b*) *Stop button*—stops the engine

(*c*) *Start button*—starts the engine only when the ignition switch on the remote control panel and the safety switch on the auxiliary power unit panel are on.

(*d*) *Safety switch (ignition)*—when this switch is ON and the ignition switch is ON at the remote control panel, the engine can be started. When off both start buttons are de-energized (i.e. remote control panel and auxiliary power unit panel).

CHAPTER 2

DETACHMENT AND DUTIES

SECTION 4: THE DETACHMENT

Primary role

19. The radar detachment (one duty watch) will consist of:

Radar 1—in command.
Radar 2—range and spotting operator.
Radar 3—bearing and bearing spotting operator.
Radar 4—director observer and relief operator.
Radar 5—plotter, power operator and relief operator.
Radar 6—reader, telephonist and relief operator.

Secondary role

20. The radar detachment (one duty watch) will consist of:

Radar 1—in command, records readings, estimates vessel size and is telephonist to the SDHQ
Radar 2—range operator.
Radar 3—bearing operator.
Radar 4—plotter.

Position in action

21. (*a*) *Primary role*

Radar 1—facing the rack panel controls clear of 2 and 3.
Radar 2—in the seat facing rack Nos. 1 and 2.
Radar 3—in the seat facing rack No. 3.
Radar 4—at the 17A director in the radar OP.
Radar 5—at the radar chart.
Radar 6—at the readers table.

(*b*) *Secondary role*

Radar 1—readers table.
Radar 2—in the seat facing rack Nos. 1 and 2.
Radar 3—in the seat facing rack No. 3.
Radar 4—at the radar chart.

SECTION 5: DUTIES OF 1

Primary role

22. (*a*) Responsible to the OPO for the working of the whole radar detachment.

(*b*) Supervising the daily maintenance and preparation for action.

(*c*) Reporting any faults to the OPO and to the radar mechanic.

(*d*) Assists in the remedying of faults, if required.

(*e*) Ensuring that all log books and maintenance sheets are kept up to date and in good order.

(f) Arranging the detachment duty roster.

(g) Supervising the starting up, closing down, testing dials and all other tests and adjustments.

(h) In action, is the radar to OP telephonist and is responsible for radar magslip switching.

(j) Recording fall of shot (when PUSS is not in use).

Secondary role

23. *(a)* Responsible to the FC for the efficient operation of the radar detachment.

(b) Estimating and reporting vessel size when ordered.

(c) Supervising starting up and closing down.

(d) Reads bearing and ranges to Radar 4.

(e) Telephonist to SDHQ.

(f) Maintaining necessary logs.

SECTION 6: **DUTIES OF 2**

Primary role

24. *(a)* Operating the radar for range measurement.

(b) Operating for range spotting and reporting observations when ordered.

(c) Reporting signal strength when ordered.

(d) Assisting in starting up, closing down, preparation for action tests, adjustments and maintenance.

(e) Reporting to Radar 1, details of faults observed in racks Nos. 1 and 2.

Secondary role

25. *(a)* Assisting in starting up and closing down.

(b) Operating for range.

(c) Reporting to Radar 1 details of faults observed in racks Nos. 1 and 2.

SECTION 7: **DUTIES OF 3**

Primary role

26. *(a)* Operating the radar for bearing measurement.

(b) Operating the bearing spotting and reporting observations to Radar 1 when ordered.

(c) Assisting in starting up, closing down, preparation for action tests, adjustments and maintenance.

(d) Reporting to Radar 1 details of faults observed in rack No. 3.

(e) Passing radar bearings to, or receiving director bearings from Radar 4 by telephone.

Secondary role

27. *(a)* Assisting in starting up and closing down.

(b) Operating for bearing.

(c) Reporting to Radar 1 details of faults observed in rack No. 3.

SECTION 8: DUTIES OF 4

Primary role

28. *(a)* Preparing 17A director for action.

(b) Operating the 17A director in the radar OP when required.

(c) Passing director bearings to or receiving radar bearings from Radar 3 by telephone.

(d) Relieving 2, 3, 5 or 6 as ordered by Radar 1.

Secondary role

29. *(a)* Plotting bearing and range, reporting target positions on radar chart.

(b) Operating auxiliary power unit when necessary.

SECTION 9: DUTIES OF 5

Primary role

30. *(a)* Plotting ranges and bearings on radar chart as received from Radar 6 during tracking.

(b) Measuring course and speed when required.

(c) Relieves 2, 3, 4, or 6 as ordered by Radar 1.

(d) Preparing auxiliary power unit and control panel for action.

SECTION 10: DUTIES OF 6

Primary role

31. *(a)* Reading bearing and range to Radar 5 during tracking.

(b) Telephonist to SDHQ, recording 5's plotting information.

CHAPTER 3

TO START UP AND CLOSE DOWN

SECTION 11: TO START UP AUXILIARY POWER UNIT

32. *(a)* Radar 1 orders "START UP AUXILIARY POWER" and prepares operating log book.

(b) Radar 5 using the remote control panel starts the power unit as follows:—

- (i) Ensures load circuit breaker is OFF.
- (ii) Puts ignition switch to ON.
- (iii) Presses starter button and notes that the red pilot light goes out.
- (iv) If engine fails to start after 30 seconds releases button, waits one minute, then repeats.

(c) When the engine starts, Radar 5—

- (i) Reverses polarity of the voltage regulator.
- (ii) Sets VR switch to ON.
- (iii) With VR rheostat, adjusts voltage to 115 volts.
- (iv) Sets the damper switch to ON.

(d) Radar 5 goes to the engine room and checks that—

- (i) The oil pressure is 10-15 lbs.
- (ii) The ammeter is indicating that the battery is being charged.
- (iii) The louvres open when the engine warms up.
- (iv) The engine is running smoothly.

(e) Radar 5 returns to the control panel and—

- (i) Checks that the voltage is correct.
- (ii) Checks that the VR contacts are not chattering or bouncing.
- (iii) If correct, he throws load circuit breaker to ON.
- (iv) Puts power selector switch to auxiliary.
- (v) Puts line regulator switch to ON.

Note.—If the auxiliary power unit fails to start after the second attempt, or does not run properly, Radar 5 reports this to Radar 1, switches on line power and reports "LINE POWER ON".

SECTION 12: TO START UP RADAR

When line power is used

33. *(a)* Radar 1 orders "START UP LINE POWER".

(b) Radar 5—At the line power rack:—

- (i) Switches line regulator ON.
- (ii) Puts power selector switch to LINE POWER.

(c) Radar 2 at racks No. 1 and 2 checks:—

(i) That the range tracking handwheel is on the zero position.

(ii) That the magslip power switch is ON.

(iii) That racks Nos. 1 and 2 doors are properly closed.

(d) Radar 3 at rack No. 3 checks:—

(i) That the AC fuzes are good and are screwed firmly into their sockets.

(ii) That rack No. 3 doors are properly closed.

(iii) That the following switches are OFF:—

Radar circuit breaker
Bearing control
Power
High voltage

(iv) That the variac is turned fully counterclockwise.

(e) Radar 5 reports "LINE POWER ON"

(f) Radar 3:—

(i) Ensures that the auxiliary circuit breaker is ON.

(ii) Throws radar circuit breaker to ON.

(iii) Throws power switch to ON.

(iv) Checks that bearing control light comes on after a short delay. If it does not come on, checks bearing rate meter and takes out any rate that may be in.

(v) When power light comes on (45 seconds), throws high voltage switch to ON.

(vi) When the high voltage light comes on (10 seconds) reports "HIGH VOLTAGE ON".

(vii) Turns variac up slowly until transmitter power supply voltmeter and milliampmeters are at the reading as laid down by the RCEME (usually 15 KV and 20 ma).

(g) Radar 2 at Racks Nos. 1 and 2.

(i) Checks that fan in rack No. 1 is working.

(ii) Adjusts brilliance, focus, horizontal and vertical shift controls for No. 1 and 2 CRTs as necessary.

Note:—The radar does not reach peak optimum performance until it has been on the air approximately 30 minutes. For this reason Radar 3 will reset the variac and magnet current controls by observing the signal on No. 2 CRT after the set has been in operation approximately 30 minutes for optimum tuning.

When auxiliary power is used.

34. *(a)* Radar 1 orders "START UP AUXILIARY POWER".

(b) Radar 2 and 3 check racks Nos. 1, 2 and 3 (section 12 para. 33 *(c)* and *(d)*.).

(c) Radar 5 starts auxiliary power unit (section 11) and reports "AUXILIARY POWER ON".

(d) Radar 2 and 3 start the radar (section 12 para 33 *(f)* and *(g)*.)

SECTION 13: TO CLOSE DOWN RADAR

35. *(a)* The OPO orders "STAND EASY" or "CEASE FIRING".

(b) Radar 1 orders "GO TO DATUM No..............."

(c) Radar 3 sets bearing rate to zero, slues to bearing of datum ordered and reports to Radar 1 "ON BEARING DATUM No............"

(d) Radar 2 sets range rate to zero, slues to datum range and reports to Radar 1 "ON RANGE, DATUM No..............."

(e) Radar 1 orders "CLOSE DOWN".

(f) Radar 3:—

(i) Switches bearing control switch to OFF.

(ii) Turns variac counterclockwise to ZERO.

(iii) Switches high voltage and power switches to OFF.

(iv) Switches radar circuit breaker to OFF.

(v) ensures auxiliary circuit breaker is ON.

(vi) Reports to Radar 1 "RADAR CIRCUIT BREAKER OFF".

(g) Radar 5 switches line regulator to OFF.

SECTION 14: TO CLOSE DOWN AUXILIARY POWER UNIT

36. *(a)* Radar 5, on hearing "RADAR CIRCUIT BREAKER OFF" at the remote control panel:—

(i) turns down voltage regulator rheostat counterclockwise.

(ii) Switches VR switch to OFF.

(iii) Switches load circuit breaker to OFF.

(iv) Switches ignition OFF and reports "IGNITION OFF".

SECTION 15: TO SUPPLY TOWER AND RACK HEATERS (WHEN RADAR IS CLOSED DOWN).

37. The order "CLOSE DOWN" means that the radar will be closed down and the auxiliary circuit breaker left in the ON position so the tower and rack heaters will keep the equipment at a constant temperature. When line power is not available, the auxiliary power unit must supply the heaters.

38. When line power is supplying the radar and will be used to supply the heaters, Radar 5 on hearing "RADAR CIRCUIT BREAKER OFF" ensures that the power selector swicth is set for LINE POWER.

39. When the auxiliary power unit is supplying the radar and line power used to supply the heaters, Radar 5 on hearing "RADAR CIRCUIT BREAKER OFF" closes down the auxiliary power unit (section 14), then changes the power selector switch to line power and reports "LINE POWER ON".

40. When line power is not available and two auxiliary power units are used:—

(*a*) Radar 1 on hearing "RADAR CIRCUIT BREAKER OFF" orders "REGULATOR OFF".

(*b*) Radar 5 turns the voltage regulator rheostat down and switches the voltage regulator to OFF.

(*c*) Radar 5 turns exciter rheostat counterclockwise to adjust voltage to 115 volts and reports "REGULATOR OFF, EXCITER CONTROL VOLTAGE 115".

41. When line power is not available, and two auxiliary power units are used, and it is necessary to close down the one operating the radar:—

(*a*) Radar 5 closes down No. 1 or 2 power unit (section 14).

(*b*) Radar 1 orders "START UP No. 2 OR POWER UNIT WITHOUT REGULATOR".

(*c*) Radar 5 starts up No. 2 or 1 power unit (section 11.)

(*d*) Radar 5 adjusts voltage with exciter rheostat to 115 volts and reports "POWER ON, UNIT No. 2 OR 1.".

CHAPTER 4

PREPARATION FOR ACTION

SECTION 16: GENERAL

42. The radar will be prepared for action at least once a day. Normally this will be carried out at the same time as the troop preparation for action. It may take place at such other times as required by the Troop Commander. The Radar detachment will fall in behind the OP detachment at manning parade.

43. Datuming (section 25) will be carried out at frequent intervals during operation, when condition permits.

SECTION 17: "TO PREPARE THE POWER UNIT FOR ACTION"

44. *(a)* Radar 1 orders "PREPARE FOR ACTION".

(b) Radar 5 at the engine room checks that:—

(i) There is sufficient fuel for the days operation.
(ii) That the dipstick in the crankcase shows the correct oil level.
(iii) The radiator is full of the appropriate coolant.
(iv) The cooling system is free of leaks.
(v) The fan belt is of proper tension.
(vi) There are no loose connections (electricial).
(vii) The ventilator control switch is in the center position.
(viii) The engine room control panel safety switch is ON.
(ix) The thermo switch on the radiator is at the correct setting.

(c) Radar 5 at the control panel in the equipment room checks that:—

(i) There are no loose connections on the terminal strip at the base of the control panel.
(ii) There are no loose connections at the load and line side of the AC terminals.
(iii) There are no loose terminals at the points of junction of the VR.
(vi) The battery charger switch is set to OFF.
(v) The ignition switch is set to OFF.
(vi) The damper switch is set to OFF.
(vii) The VR switch is set to OFF.
(viii) The load circuit breaker switch is set to OFF.
(ix) The VR rheostat is turned fully *counterclockwise*.
(x) the exciter field rheostat is turned fully *clockwise*.

(d) Radar 5 checks at the line power rack:—

(i) That the line regulator fuzes are good and screwed firmly in.

(ii) that the line regulator switches are in the OFF and AUTO positions.

(iii) That the auxiliary lighting switch is in the ON position

(e) Radar 5 reports to Radar 1 "POWER UNIT READY FOR STARTING".

(f) Radar 1 orders "START UP AUXILIARY POWER UNIT" (section 11).

SECTION 18: **TO PREPARE RADAR FOR ACTION**

45. *(a)* Radar 2 and 3 start up radar (section 1). To check Nos. 1 and 2 CRT's.

46. *(a)* Radar 2 checks that time bases with markers appear on screens on the CRT's.

(b) Radar 2 checks that the operate marker and error marker are of correct width (approximately 250 yards) and that the following controls operate:—

(i) Horizontal shift.
(ii) Vertical shift.
(iii) Focus.
(iv) Main gain.
(v) Brilliance.
(vi) The range error control moves the error marker the whole length of No. 2 sweep when the spotting control switch is depressed.

To check the range controls and limit switches

47. Radar 2 checks:—

(a) The operation of the range tracking control for 5,000 yards in each direction.

(b) The operation of the slow range slueing for 5,000 yards in each direction.

(c) The operation of the fast slueing and limit switches by slueing to maximum range—limit switch should cut out at approximately 37,000 yards.
Slue to minimum range—Limit switch should cut out at slightly less than zero.

(d) That when range carriage is inside inner transmitting limit, magslip pointers go to the battery magslip datum.

To check calibration.

48. *(a)* Radar 2 switches the output selector switch to position 3 and checks that the calibration pips appear (when viewed against the range error scale on the No. 2 CRT)

(i) At zero with operate marker.
(ii) At plus 1,000 yards.
(iii) At minus 1,000 yards.

(b) Radar 2 switches the output selector switch to position 1.

To check zero range error

49. *(a)* Radar 2 acts as follows:—
    - (i) Using range controls brings the leading (left hand) edge of the transmitter pulse coincident with the leading edge of the operate marker.
    - (ii) Checks reading or radar range dials, which should be zero.

(b) If correct, Radar 2 reports "ZERO RANGE ERROR NIL".

(c) If not correct, Radar 2 reports "ZERO RANGE ERROR............................YARDS".

(d) Range is left at zero while Radar 3 tunes the transmitter.

To tune the transmitter

50. With the range at zero, Radar 3 adjusts the variax and magnet current control to obtain the best tuning of the transmitter pulse as viewed on No. 2. CRT. Radar 3 ensures the magnet current does not exceed 150 ma, or the average pulse current 20 ma. When correct Radar 3 reports "TRANSMITTER TUNED".

Checks on rack 3

51. Radar 3 checks that:—

(a) The bearing gun needle is centered.

(b) That the gun/radar bearing switch on the bearing magslip test box, operates.

To check the bearing controls and limit switches.

52. *(a)* Radar 3 puts the bearing control switch to ON, the bearing control selector switch to TRACKING and checks:—
    - (i) Rate laying in each direction.
    - (ii) Positional laying in each direction.
    - (iii) Aided-laying in each direction.
    - (iv) That the bearing rate meter operates both at main and vernier.

(b) Radar 3 puts the bearing control selector switch to SLUEING 1 and checks the:—
- (i) Slueing 1 control in each direction.
- (ii) Slueing 1 rate control.
- (iii) Tower limit switches by slueing to the limit in each direction.
- (iv) Checks displacement converter magslips by pressing the orient check button and slueing 10 degrees, then releasing.

(c) Radar 3 puts the bearing control selector switch to SLUEING 2 and reports "ON SLUEING TWO".

(d) Radar 2 using slueing 2 controls:—
- (i) Slues 10 degrees in each direction.
- (ii) If correct, reports "SLUEING TWO CORRECT".

To check the hunter magslip.

53. *(a)* Radar 3 ensures bearing control selector switch is at SLUEING 1, slues to the bearing of an appropriate datum and reports "ON BEARING DATUM No......................"

(b) Radar 2 lays accurately on datum for range and reports "ON RANGE, DATUM No......................"

(c) Radar 3 lays accurately on the datum for bearing, using the bearing meter needle.

(d) Radar 4 lays the director on the datum named and reports "DIRECTOR ON DATUM No...........BEARING......."

(e) Radar 3 checks the bearing given by 4 with the radar bearing dial and if within 5 degrees:—

(i) Switches the hunter magslip to MAIN and centers the needle.

(ii) Switches the hunter maglsip to VERNIER and again centers the needle.

(iii) Checks bearing with 4 and if they agree accurately he reports "HUNTER MAGSLIP CORRECT".

(iv) Switches the hunter magslip to OFF.

To check the tuning of the receiver

54. With radar laid on a suitable datum, or PE, Radar 2 adjusts the oscillator current and oscillator tune for maximum echo on the No. 2 CRT, ensuring that the crystal current does not exceed ·7 ma. and oscillator current does not exceed 7 ma.

SECTION 19: TO PREPARE 17A DIRECTOR FOR ACTION

55. *(a)* Radar 4 in OP:—

(i) Tests director traverse in both directions, and speeds throughout its arc.

(ii) Lays on a datum, focuses, sets correct eyepiece and checks bearing to datum.

(b) Lays on a second datum (if possible) and checks bearing.

(c) If bearings are not correct Radar 4 reports the fault to Radar 1.

SECTION 20: TO PREPARE PLOTTING EQUIPMENT FOR ACTION

56. *(a)* Radar 5 checks:—

(i) That the lights in the chart are working.

(ii) That the plotting stores are complete
Range arm
Chinagraph pencils.
Eraser
Protractor with speed scale.

(iii) That the chart is clean.

(b) Radar 6 checks that the stop-watch is available and working.

(c) When Radar 2 and 3 have completed testing dials and datuming, Radar 6 positions the dials for plotting.

SECTION 21: TO CHECK CALIBRATION OF THE MAIN GAIN DIAL

General

57. The calibration of the main gain dial must be carefully checked daily as it is liable to drift. If the set is carrying out size estimation procedure, the calibration must be checked every watch. If the calibration has changed all that may be needed is an adjustment of the zero position by means of the pre-set gain by the radar mechanic. In most cases it is necessary to recalibrate; (Appendix "A") this is nearly always needed after a change has been made in the receiver circuits, eg., when an amplifier tube has been replaced.

To check

58. At preparation for action, change of watch, or going on the air, Radar 2 must check the gain calibration as follows:—

(a) With the co-operation of Radar 3, switch on and tune the set.

(b) Check time base for correct vertical position on CRT.

(c) Check setting of pre-set gain control as follows:—
- (i) Turn hand gain control fully up.
- (ii) Rotate aerial until a 2 to 1 signal is found.
- (iii) Check that extreme tip of echo just beats up to the 6-db mark on the vertical scale. Pre-set gain is adjusted, if necessary by radar mechanic. Any adjustments of pre-set gain necessitates re-calibration of the gain control.

(d) Check uncorrected db., calibration of the hand gain control on steady permanent echoes as follows:—
- (i) Turn gain fully up.
- (ii) Rotate aerial until a steady PE just touches the 5 db line.
- (iii) Set hand gain control at 5 db (uncorrected)
- (iv) Check that PE is within 1 db. of datum line.
- (v) If echo is not within 1 db. of datum line, the gain control must be re-calibrated.
- (vi) Repeat for each 5 db. (uncorrected) setting of the gain control.

SECTION 22: TO CHECK SET PERFORMANCE AND CORRECTION FACTOR

General

59. When the set is on the air, the set performance must be checked at hourly intervals or whenever possible, on three selected PE's. A standard performance figure must previously have been determined for these PE's (performance checks and estimation of vessel size on CDX No. 2, Mk 1 Radar sets 1946-4-1). The hourly average is compared with this standard.

To check

60. *(a)* Radar 1 orders "CHECK PERFORMANCE, GO TO FIRST PE".

(b) Radar 2 and 3 lay accurately on the first PE and report "ON RANGE" "ON BEARING".

(c) Radar 2 measures signal strength (Section 23) and reports "FIRST PE STRENGTH.................DECIBELS"

(d) Radar 1 logs (Appendix "D" (iv)) this figure and orders "GO TO SECOND PE".

(e) The drill (para. 60 *(a)* to *(c)* is repeated for the second and third PE.

(f) Radar 1 logs the mean of three or more db. readings, subtracts this from the standard performance figure. The remainder is the performance correction factor.

(g) The performance correction factor is added to or subtracted from the mean db. readings when carrying out estimation of vessel size procedure (section 48).

SECTION 23: TO MEASURE SIGNAL STRENGTH

General

61. Signal strength is measured when checking set performance, datuming and estimation of vessel size.

62. *(a)* Radar 2 measures signal strength as follows:—

(i) Reduces main gain until maximum beat of echo comes just above the datum line.

(ii) notes the maximum beat registered against the vertical decibel scale.

(iii) Adds this to the setting of the main gain.

(iv) when reporting gives the final figure only.

SECTION 24: TO CHECK CALIBRATION OF BEARING ERROR CONTROL DIAL

63. *(a)* Radar 2 and 3 lay accurately on a datum, as ordered by 1.

(i) Radar 2 depresses spotting switch and accurately positions the echo in the error marker.

(ii) Radar 3 notes the bearing to the nearest minute.

(iii) Radar 3 checks that with the bearing error control at zero, the bearing meter needle is centered.

(iv) Radar 2 releases the spotting switch.

(b) Radar 3 lays the radar off bearing 15 minutes right.

(i) Radar 2 depresses the spotting switch and accurately positions the echo in the error marker.

(ii) Radar 3 accurately centers the bearing meter needle with the bearing error control.

(iii) Bearing error control dial should read 15 minutes left.

(c) The procedure is repeated for every 15 minutes up to two degrees right and left.

(d) If the calibration is not correct Radar 1 with the help of 2 and 3 will recalibrate the bearing error control dial (Appendix "B")

SECTION 25: DATUMING (SEE APPENDIX D-I)

General

64. Datum points must be fixed, well defined objects giving saturation echoes on the No. 2 CRT. They should be at different ranges and/or bearings.

Drill

65. *(a)* Radar 1 orders "GO TO No. 1 DATUM".

(b) Radar 3 slues to datum bearing.

(c) Radar 2 lays accurately on datum for range and reports "ON RANGE DATUM No. 1."

(d) Radar 3 lays accurately on datum for bearing and reports "ON BEARING DATUM No. 1".

(e) Radar 2/3 record both radar range/bearing and gun range/bearing.

(f) Radar 2/3 slue off range/bearing alternately in each direction, re-lay and record readings a total of six times.

(g) Radar 2 averages the range and reports "DATUM No. 1 RADAR RANGE................GUN RANGE..............SIGNAL STRENGTH..............."

(h) Radar 3 averages the bearings and reports "DATUM No. 1, RADAR BEARING..............GUN BEARING.........." (to nearest minute).

(j) Radar 1 records the result and orders "GO TO No. 2 DATUM".

(k) The procedure (para 65 *(b)* to *(j)*) is repeated for all datums.

Note: If the average bearing/range (gun or radar) differs by more than 10 minutes/25 yards from the known, the No. 1 will report this to the radar mechanic. This gives a quick check on the accuracy of both the converter and radar.

SECTION 26: TO COLLECT REPORTS

General

66. *(a)* Radar 1 when satisfied that the members of the detachment have completed their duties at preparation for action, will call the detachment to attention and collect reports.

(b) Radar 3 will pass to 4 orders/reports which concern him by telephone, during this and any other drill.

Drill

67. *(a)* Radar 1 orders "REPORTS.............................2"

(b) Radar 2 reports "CORRECT................(or otherwise)"

(c) This is repeated for each number of the detachment.

68. When Radar 1 has received "CORRECT" reports from the whole detachment, he will report to the OPO "RADAR READY FOR ACTION".

CHAPTER 5

TESTING COMMUNICATIONS AND MAGSLIP TRANSMISSION

SECTION 27: **GENERAL**

68. Communications are the responsibility of the Royal Canadian Corps of Signals. Any faults found during the testing of communications will be reported to the responsible Signals unit as soon as possible. Attempts to rectify faults will not be made by RCA personnel except in an emergency.

SECTION 28: **TO TEST TELEPHONES**

69. Telephones are tested at preparation for action of the battery. (CAD part 3. Pam 1. section 20-21)

70. Communications in the radar will include the following circuits:—

- *(a)* OPO in OP to Radar 1. Test initiated by OPO.
- *(b)* Radar 3 to 4. Test initiated by 3.
- *(c)* SDHQ to Radar 6. Test initiated by SDHQ.

SECTION 29: **TO TEST SHOT AND LOOK-IN INDICATORS**

General

71. The testing of these indicators, if installed, is controlled by OPO. Orders and reports are passed to and received from Radar 1 by telephone.

Drill

72. *(a)* OPO orders "TEST SHOT INDICATORS".
- *(b)* OPO orders "REPORT".
- *(c)* Radar 1 ensures:—
  - (i) The shot indicator bell rang.
  - (ii) The appropriate lamp lighted.
  - (iii) The look-in indicator bell gave a satisfactory double ring.
- *(d)* Radar 1 reports "RADAR CORRECT" (or otherwise).
- *(e)* This drill is carried out for both contacts on each gun, followed by the testing of all guns at once.

SECTION 30: **TO TEST DIALS**

General

73. The procedure is designed to test the data transmission systems between:
- *(a)* 6-*in*:—
  - (i) The primary rangefinder (RADAR) and the guns direct.

(ii) The secondary rangefinder (DRF tx) and the guns direct.

(iii) The primary rangefinder (RADAR) and FDT.

(iv) FDT and guns.

(b) 4-*in*:—

(i) The primary range-finder (RADAR) and the transceiver bearing and range to QE converter.

(ii) The No. 17A director and the transceiver bearing.

(c) Magslip test points are laid down as follows:—

RANGE

1st TEST POINT : 8,000 yards
2nd TEST POINT : 13,000 yards
3rd TEST POINT : 25,000 yards

BEARING

1st TEST POINT : A whole 10 degrees in the right arc of fire.
2nd TEST POINT : 10 degrees to the left of the first test point.
3rd TEST POINT : 124 degrees to the left of the second test point.

(d) Testing of the data transmission system is supervised by the OPO. or TA.

Procedure

74. 6-*in BATTERIES*

(a) OPO orders "TEST DIALS, ROUTE......................."

(b) Radar 1 sets appropriate switches and reports "RADAR READY TO TEST DIALS ROUTE.................CONTACT".

First test point

75. *(a)* OPO orders "RADAR GO TO FIRST TEST POINT".

(b) Radar 1 repeats to 2 and 3 "GO TO FIRST TEST POINT".

(c) Radar 2 and 3 set dials to first test point reading.

(d) Radar 2 and 3 report RANGE/BEARING FIRST TEST POINT ON."

(e) Radar 1 reports "RADAR FIRST TEST POINT ON".

Second test point

76. *(a)* The procedure in para. 75 is repeated, but for the second test point.

(b) Radar 2 and 3 set dials slowly and smoothly to the second test point reading.

Third test point

77. *(a)* OPO orders "SWITCH OFF".

(b) As soon as power switches have been switched off and reported "SWITCHED OFF", OPO will order "GO TO THIRD TEST POINT". This order will be carried out as in para. 75.

(c) Upon receiving the report "RADAR THIRD TEST POINT ON" the OPO will order "SWITCH ON".

To Test Alternative bearing

78. It may be found that 6-in MK 7 units equipped with radar are able to transmit bearing direct from the 17A director to guns or if a bearing transceiver is installed, to the bearing transceiver. In this case the 17A director may be considered an alternative means of finding bearing, therefore upon the order "GO TO FIRST TEST POINT" the director would go to second test point and remain there until the alternative route has been tested. The alternative route will be tested as follows:—

(a) After the primary route and sources have been tested, the OPO will order "TEST ALTERNATIVE BEARING, SWITCH TO ROUTE.................".

(b) All will report to the route ordered and report back "ROUTE ....CONTACT".

(c) The OPO will order "READ".

(d) As the route ordered has switched director information to the transceiver, or to the gun direct, the dials should now read SECOND TEST POINT.

Changing to Radar/Visual

79. *(a)* The order is passed to set the appropriate route or "RADAR SWITCH TO VISUAL/RADAR" which ever is applicable.

(b) Radar 1 makes the necessary changes in the changeover switches and reports "ROUTE................CONTACT or RADAR VISUAL/RADAR CONTACT".

Conclusion

80. *(a)* OPO orders "DIALS CORRECT, SWITCH TO ROUTE........"

(b) Radar 1 acknowledges, makes the correct route setting and reports "RADAR ROUTE................CONTACT".

Procedure

4-*in BATTERIES*

Note: Each battery may have its own procedure laid down in Battery Standing Orders depending on the magslip layout.)

81. Testing between radar and intermediate data transmission instruments (viz: transceiver bearing and range to Q.E. converter) is carried out as for paragraphs 74 to 80 as well as testing from these instruments to the guns.

82. The alternative bearing will be tested as for para. 78.

SECTION 31: TO CHECK DIALS

General

83. Dials are checked at the end of a series or engagement. The procedure is initiated by the order from the OPO "SCALES ZERO", "CHECK DIALS".

Procedure

84. *(a)* Order by OPO "CHECK DIALS".

(b) Radar 1 orders "CHECK DIALS".

(c) No. 1 ensures that No's. 2 and 3 set the tracking devices to zero rate.

(d) Radar 2 and 3 slues to the nearest whole ten (10) degrees of bearing and nearest whole thousand yards of range and reports "RANGE ....ON" "BEARING..................ON".

(e) Radar 4 traverses to the nearest whole ten (10) degrees of bearing and reports "DIRECTOR, BEARING..............ON".

(f) Radar 1 reports "RADAR BEARING................RANGE ....ON".

(g) When dials are correct the report to Radar 1 is "DIALS CORRECT".

CHAPTER 6

DRILL (PRIMARY ROLE)

SECTION 32: TO LOCATE A TARGET

Using Radar Bearings

85. *(a)* Radar 2 on observing a target in No. 1 CRT will report "TARGET".

(b) Radar 3 hearing "TARGET" will immediately stop slueing.

(c) Radar 2 proceeds as follows:—

(i) Move the operate marker in No. 1 CRT in the direction of the target with the fast range slueing control.

(ii) When the target appears in No. 2 CRT bring it accurately into the operate marker in No. 2 CRT with the slow range slueing control.

(iii) Keep the leading, left hand edge of the operate marker by setting rate with range tracking handwheel.

(d) Radar 3, hearing "ON RANGE ETC", will bring the bearing meter needle to the center position using the bearing slueing 1 controls. When centered:—

(i) Reports "ON BEARING".

(ii) Switch the bearing control selector to tracking.

(iii) Keep the bearing meter needle centered with the bearing tracking (aided-laying) controls.

Using Director Bearing

86. *(a)* The drill detailed in para. 87 is carried out simultaneously with para. 88.

(b) Radar 3 passes the order "TARGET VISIBLE" to 4 and also the bearing reported by 5. He will also give 4 any other information, including direction of movement which will aid 4 in identifying and locating the proper target.

(c) Radar 4 identifies and lays on the foremast of the target and reports to 3 "DIRECTOR ON TARGET, BEARING................" (to the nearest degree).

(d) Radar 4 lays continuously on the target and reports bearing to 3 every thirty seconds interval, until 3 reports "ON DIRECTOR BEARING".

(e) Radar 3 checks the bearing reported by 4 with this radar bearing dial and if it agrees within 5 degrees will proceed as follows:—

(i) Switch hunter magslip to MAIN

(ii) Center hunter magslip needle with bearing slueing 1 controls.

(iii) Switch hunter magslip to VERNIER.

(iv) Center hunter magslip needle with bearing slueing 1 controls.
(v) Reports "ON DIRECTOR BEARING" to Radar 1 and 4.
(vi) Switch bearing control selector to tracking.
(vii) Keep the hunter magslip needle centered with the bearing tracking controls.

87. When 2 slues to the bearing reported by Radar 5 and is unable to observe a target, he will report "NO TARGET". Radar 1 keeping in mind the direction of the movement of the target will order "SLUE RIGHT/LEFT 10 DEGREES" and if necessary Radar 6 will call for further plots from SDHQ.

SECTION 33: TO TRACK A TARGET

General

88. *(a)* The initial order is passed to Radar 1 by telephone from the OPO and will contain the following:—
(i) executive order "RADAR TRACK".
(ii) target identification from SDHQ.
(iii) direction of movement, north, south, east or west.
(iv) co-ordinates of the target position in GEOREF.
(v) time of last plot.
(vi) if target is visible and the OPO wishes the 17A director to be used, the message is concluded with "TARGET VISIBLE".

(b) If on receipt of the initial order the radar is not operating it will be started (section 12).

Using Radar Bearings

89. *(a)* Radar 1 receives and repeats the order "RADAR TRACK.......... MOVING.....................TIME..................".

(b) Radar 5 converts the reference to range and bearing and reports "RANGE................BEARING................".

(c) Radar 2/3 slues to the range/bearing reported and locates target (section 32 para. 87).

(d) Radar 5/6, hearing "ON RANGE/BEARING" will carry out the drill for monitoring by SDHQ (section 40) and when correct will report "ON TARGET".

(e) Radar 1 reports "RADAR ON TARGET ECHO GOOD (FAIR, POOR)". (Section 38) to the OPO.

(f) Radar 2/3 continue tracking for range/bearing.

Using Director Bearing

90. When the 17A director is used with radar, the radar will pass normal rangefinding information. Bearing tracking will be done by the director and bearing fall of shot observed visually by stereoscope or binoculars.

Bearing data is passed via magslip from the director to the hunter unit, the bearing output of the radar also fed to the hunter unit. The hunter unit produces the difference between the two bearing outputs and so the radar bearing is made to coincide with the director bearing by rotating the radar tower until the hunter needle is centered. The radar bearing is then converted to gun bearing by the radar converter, and the output passed in the usual manner. Therefore when the director is being used, Radar 3 will track for bearing by keeping the hunter needle centered at vernier after first centering at main. The hunter unit switch must never be moved from the center position unless the director bearing reported by Radar 4 and the radar bearing agree within 5 degrees.

91. *(a)* Radar 1 receives and repeats the order "RADAR TRACK......... MOVING..........TIME..........TARGET VISIBLE".

(b) Radar 5 converts the reference to range and bearing and reports "RANGE............BEARING............".

(c) Radar 2/3 slue to the RANGE/BEARING reported.

(d) Radar 2, 3 and 4 locate target (section 32 para 88).

(e) The drill detailed in para. 91 *(d)* and *(e)* is carried out.

(f) Radar 2, 3 and 4 continue tracking for range/bearing.

To Change to Director Bearings from Radar Bearings

92. If the radar is tracking a target by radar bearings and it is desired to change to director bearings, Radar 3 passes radar bearings to 4 at 30 second intervals from the radar bearing dial. The bearing reported by Radar 4 when on target must agree with the radar bearing dial or there may be a possibility of 4 being on the wrong target. When correct target is identified the drill detailed in para. 88*(b)* to *(e)* is carried out.

To Change From Director To Radar Bearings

93. *(a)* If the OPO decides to change from director to radar bearings:

- (i) OPO orders "RADAR TRACK RADAR BEARINGS".
- (ii) Radar 1 orders "TRACK RADAR BEARINGS".
- (iii) Radar 3 switches hunter magslip to OFF and tracks by keeping bearing meter needle centered.
- (iv) Radar 3 reports to 1 and 4 "ON RADAR BEARING".
- (v) Radar 4 stops laying with director.
- (vi) Radar 1 reports to OPO "RADAR, ON RADAR BEARINGS".

(b) If the target becomes obscured:—

- (i) Radar 4 reports "TARGET OBSCURED"
- (ii) Radar 3 switches hunter magslip to OFF and tracks by keeping bearing meter needle centered. Reports to 1 "TARGET OBSCURED, ON RADAR BEARING".
- (iii) Radar 1 reports to OPO "RADAR, TARGET OBSCURED, ON RADAR BEARINGS".

SECTION 34: TO PLOT

General

94. Plotting is carried out on the radar chart. The one in general use being boards plotting illuminated (GLP) No. 2. Mk. 1. This scale should be at least 1,000 yards to the inch, and with this scale the plotting interval of 30 seconds is considered the most practical. With a larger scale a shorter plotting time can be used.

Drill

95. *(a)* Radar 6 on hearing "ON TARGET" from 1 commences reading to 5 and recording bearings and ranges from the gun bearing dials every 30 seconds.
   - (i) Bearings to the nearest 30 minutes.
   - (ii) Ranges to the nearest 100 yards.
   - (iii) After the initial reading the words bearing, range, degrees etc., need not be repeated.

(b) Radar 5 using the range arm and bearing scale plots as follows:—
   - (i) Swings the range arm to the bearing reported by 6.
   - (ii) Opposite the range reported he makes a mark on the chart (dot) using a chinagraph pencil.
   - (iii) Circles the initial plot and every subsequent second plot.

(c) At the end of one minute (the third plot) Radar 6 orders "COURSE AND SPEED".

(d) Radar 5 measures and reports course and speed (section 35).

(e) After passing the course and speed to Radar 1, 5 and 6 continue to plot.

(f) If Radar 5 detects the target turning to port/starboard he reports to 1 "TARGET TURNING TO PORT/STARBOARD". Radar 1 passes this on to the OPO.

SECTION 35: MEASURING AND REPORTING COURSE AND SPEED

96. Course and speed are measured with a protractor and speed scale. The speed scale is engraved showing knots for one minute of travel. The initial course and speed is taken as soon as possible after the report "RADAR ON TARGET, ETC.". Subsequently it is taken only when ordered by OPO.

Drill

97. *(a)* Radar 6 orders "COURSE AND SPEED".

(b) Radar 5 measures course and speed as follows:—
   - (i) Places the speed scale on the chart in line with the plot. Ensuring the scale is pointing in the direction of movement of the target.
   - (ii) Lines the 0-180 degree line of protractor up with a north south line on the chart.

(iii) Reads the course off the protractor at the intersection of the speed scale.

(iv) Reads the speed from the speed scale.

(v) Mark the course and the speed on the chart, opposite the plot, also the time received from Radar 6.

(c) Radar 5 reports to 6 "COURSE............SPEED...........".

(d) Radar 6 reports to 1 "RADAR COURSE........SPEED........ TIME........".

(e) Radar 1 passes course and speed to OPO "RADAR COURSE....... SPEED........TIME........".

SECTION 36: **MERGING TARGETS**

General

98. When two targets are at the same range and within 3 degrees for bearing they will appear as one echo on the time base and then it is practically impossible for Radar 2 to distinguish between them. However, if 2 or 3 were tracking the observed target accurately before the merge they should be able to track it through the merge without altering their rates, unless the target changes course during the merge. In this case it is almost impossible to keep on the correct target, particularly if both targets are running approximately the same course.

99. In cases where the target is visible and the 17A director is in use, Radar 4 will be able to track the correct target and should assist 2 and 3 in keeping on the target.

100. Monitoring will be carried out with SDHQ to ensure that the radar is on the correct target once the targets are clear.

Drill

101. *(a)* When it becomes obvious that another echo is going to merge with the one being tracked Radar 2 reports "TARGET MERGING".

(b) Radar 1 reports to OPO "RADAR TARGET MERGING" in order to indicate radar information may be unreliable.

(c) Radar 3 reports to 4 "TARGET MERGING" so 4 can assist 2 and 3 with information with regard to the movement of position of the target.

(d) Radar 2 and 3 leave the rates set unless it becomes obvious that the rates are drastically wrong.

(e) Radar 5 and 6 continue to plot (section 34.).

(f) When the echoes are clear Radar 2 reports "TARGET CLEAR".

(g) Radar 3 repeats to 4 "TARGET CLEAR".

(h) Radar 5 and 6 carry out the drill for monitoring by SDHQ (section 40) and when on, report "ON TARGET".

(j) Radar 1 reports to OPO "RADAR TARGET CLEAR".

SECTION 37: TO OBSERVE AND REPORT FALL OF SHOT

General

102. When the battery engages a target being tracked by radar and fall of shot observations by radar are required, the OPO will advise Radar 1, who will in turn warn the detachment by the order "RADAR SPOTTING".

(a) With the CDX using "A" type presentation, ranging will be by ranging salvos procedure, therefore radar will report "PLUS" or "MINUS" only and not the amount.

(b) When the 17A director is being used for bearing, an observor in the OP will observe for line.

(c) When the PUSS is in use, Radar 2 will be only required to strobe the shell splash with the error marker. Reports from the radar detachment are not necessary in this case.

(d) In batteries not equipped with look-in indicators, Radar 1 will receive "LOOK-IN" from the OPO 5 seconds before the end of the time of flight. Radar 1 will pass this on to 2 and 3.

Drill

103. *(a)* Radar 2 on receipt of the order "RADAR SPOTTING" will line up the leading edge of the operate marker with the zero of the error scale on No. 2 CRT, using the horizontal shift control.

(b) When the look-in bell rings or No. 1 orders "LOOK-IN", Radar 2 and 3 leave range/bearing rates set and 2 observes No. 2 CRT for a splash echo.

(c) On observing a splash echo, Radar 2 reports "SPLASH" and strobes it as follows:—

- (i) depresses the spotting switch,
- (ii) quickly positions the error marker under the splash echo with the range error control.
- (iii) observes position of splash echo with relation to target echo (i.e. plus or minus).

(d) Radar 3 on hearing "SPLASH" centers the bearing meter needle with the bearing error control and notes the reading.

(e) When the splash subsides, Radar 2 reports "SPLASH GONE".

(f) Radar 1 orders "READ".

(g) Radar 3 reports ".........DEGREES..........MINUTES RIGHT/LEFT" or "LINE".

(h) Radar 2 reports "PLUS/MINUS" or "RANGE".

(j) Radar 1 records this information and reports to the OPO: "RADAR SALVO................DEGREES................MINUTES RIGHT/LEFT, PLUS/MINUS".
(Appendix "D" (ii)).

Note: If the round or salvo is not seen on No. 2. CRT, Radar 2 will report "OU" (unobserved)" Radar 3 will make no report. Radar 1 if observes the splash on No. 1 CRT, will report the range error as accurately as possible. If 17A director is in use for bearing, Radar 3 will make no report on the order "READ".

SECTION 38: REPORTING ECHO STRENGTH

104. The following classification will be used in reporting echo strength:—

(a) GOOD—The echo is to saturation and can be tracked with ease.

(b) FAIR—The echo is strong with slight beating, but may be tracked accurately.

(c) POOR—The echo is beating badly but can be tracked with care.

SECTION 39: REPORTING TRAVEL RATES

105. *(a)* If the OPO wishes travel rates from the radar, he will order "RADAR REPORT, TRAVEL RATES".

(b) Radar 1 orders "TRAVEL RATES".

(c) Radar 3 reads the bearing rate meter, depressing the vernier switch if necessary and reports "BEARING INCREASING (DECREASING)................DEGREES PER MINUTE" or "BEARING STATIONARY".

(d) Radar 2 reads the range rate dial and reports "RANGE OPENING (CLOSING)..........YARDS PER MINUTE" or "RANGE STATIONARY".

(e) Radar 1 reports this to the OPO.

SECTION 40: MONITORING BY SDHQ.

106. During action Radar 6 will be in communication with a plotter in SDHQ, who will be able to assist the radar in picking up the correct target, either initially or when the targets have become clear, after merge.

All reports to/from Radar/SDHQ will be preceded by battery radar designation.

Initial tracking

107. *(a)* On hearing "ON RANGE/BEARING" from 2/3 (section 33) Radar 6 will read the bearing and range to 5.

(b) Radar 5 plots this, converts it into GEOREF and reports this to 6.

(c) Radar 6 reports to SDHQ "...............(battery radar designation) ON TARGET.............(target No.).............GEOREF position)".
(eg: "RADAR ON TARGET SKUNK EASY 24653298").

(d) SDHQ plotter compares this with the latest plot of that target.

(e) If correct:—

- (i) SDHQ plotter report "..............CORRECT" to Radar 6.
- (ii) Radar 6 reports to 1 "ON TARGET".

(f) If wrong:—

- (i) SDHQ plotter report "..............WRONG" and gives correct target position.

(ii) Radar 6 repeats this to 5 who converts it to range and bearing which is passed to 2 and 2, who endeavour to lay on the correct target.

(iii) When on 2/3 report "ON RANGE/BEARING" and the above drill is repeated.

Merging targets

108. *(a)* When 6 hears "TARGET MERGING" from Radar 2 he reports "......................TARGET MERGING".

(b) SDHQ plotter will keep a careful check on both targets and pass any information which may help Radar 6.

(c) When Radar 5 gears "TARGET CLEAR", he will pass the co-ordinates to 6.

(d) Radar 6 reports to SDHQ "......................TARGET (designation) ....CLEAR" and gives the co-ordinates.

(e) The drill in para. 107 *(d)*, *(e* or *f)* is carried out.

SECTION 41: **TO STOP**

109. *(a)* The order "STOP" is for the guns to stop firing and does not affect the radar.

(b) "STOP" is cancelled by "GO ON" or a new sequence of initial orders.

SECTION 42: **TO REST**

110. *(a)* Radar 1 receives the order from the OPO and orders any necessary work done around the radar. Changes operators around etc.

(b) Radar 2 continues to follow roughly for range.

(c) Radar 3 repeats "REST" to 4 and continues to follow roughly for bearing. If using director, switches hunter magslip to main.

(d) Radar 4 follows roughly with director.

(e) Radar 5 and 6 stop plotting.

111. The "REST" is cancelled by "TAKE POST" or a fresh sequence of initial orders.

SECTION 43: **TO STOP TRACKING**

112. This order is used when the OPO no longer wants the radar to track, but wishes it to be kept on the air.

Drill

113. *(a)* Radar 1 on receipt of the order "RADAR, STOP TRACKING" from the OPO, orders "STOP TRACKING".

(b) Radar 2/3 zero range/bearing rates.

(c) Radar 3 repeats "STOP TRACKING" to Radar 4 and switches hunter magslip to OFF position if necessary.

(d) Radar 5 and 6 stop plotting.

(e) Radar 1 changes operators around.

114. (a) "STOP TRACKING" is cancelled by a fresh sequence of initial orders.

SECTION 44: TO STAND EASY

115. (a) The OPO orders "STAND EASY" (AT Vol V Pt. 1 Pam 6.).

(b) The radar is closed down (section 13).

(c) Radar 1 appoints a duty man and withdraws the detachment to the position detailed by the OPO.

SECTION 45: TO CEASE FIRING

116. (a) The OPO orders "CEASE FIRING" (AT Vol V Pt. 1 Pam 6.).

(b) The radar is closed down.

(c) Radar 1 ensures the equipment room is left in a clean and tidy condition, then gives the applicable instructions to the detachment and breaks them off.

CHAPTER 7

DRILL (SECONDARY ROLE)

SECTION 46: TO SWEEP

Preparation

117. *(a)* When the F Comd. wishes a CDX radar ro relieve a tactical control radar he will order "................PREPARE TO SWEEP" to the OPO.

(b) OPO orders Radar 1 "RADAR PREPARE TO SWEEP".

(c) On receipt of this order the Radar No. 1 is ordered to start up by the OPO (section 12.).

(d) Radar 1 calls for plots of all targets from the SDHQ plotter, and passes them to 4 who plots them on the radar chart.

(e) When *(d)* is completed and the radar is operating, Radar 1 reports to the OPO "RADAR, READY TO SWEEP".

(f) OPO reports to F Comd "...................READY TO SWEEP".

Drill

118. *(a)* If a normal arc is to be swept as laid down in Standing Orders, the F Comd. orders "..............SWEEP", to the OPO. OPO orders Radar 1 "RADAR SWEEP".

(b) Radar 1 repeats the OPO's order to the detachment who proceed as follows:—

(i) Radar 3 slues throughout the normal arc until 2 reports "TARGET".

(ii) On observing a target in No. 1 CRT, Radar 2 reports "TARGET" and tracks for range, reporting "ON RANGE" (para 87*(c)*).

(iii) Radar 3 tracks for bearing (para 87. *(d)*).

(c) Whenever a new target is reported, Radar 2 and 3 should track it for approximately two minutes.

(d) Radar 1, on the report "ON RANGE/BEARING" reads and reports bearing and range to 4 who plots the target position on the chart.

(e) Radar 4 converts plot to GEOREF, passing this to 1 who reports it to SDHQ together with size estimation, if required.

(f) SDHQ will pass to Radar 1, who repeats to 4, the allotted track No. as soon as available.

(g) Radar 1 records all pertinent information in the log for routine sweeping (Appendix "D" (iii)).

(h) Initial and subsequent information on all targets are passed to SDHQ.

119. Sweeping should be carried out at a rate that will cover the arc completely every 10 to 15 minutes. It will usually be found preferable to give readings only when sweeping in one direction, eg: clockwise, and to observe for new targets while sweeping in the other direction.

After two or three sweeps the operators will usually recognise any new target as such, as soon as it appears in the sweep. In doubtful cases, they should make use of the recordings in the log for routine sweeping. The display unit on the top of the range operators table is also helpful in identifying targets, especially those which may be mistaken for buoys, land and other fixed objects.

SECTION 47: TO SEARCH

General

120. If the F Comd suspects there is a target in a certain arc or area, he will order a search of that arc or area. The arc of search will usually be ten degrees or less. Inner and outer range limits may also be given.

Drill

121. *(a)* Radar 1 receives and repeats the order "..............SEARCH BEARING...............TO BEARING.................... (RANGE............TO............).

(b) Radar 2 and 3 slue to the range/bearing ordered and start to search.

(c) Searching is carried out in the same manner as sweeping except that a much closer watch for targets is kept and readings are reported while traversing in both directions.

SECTION 48: TO ESTIMATE AND REPORT VESSEL SIZE

General

122. *(a)* Size estimation is taken to assist SDHQ in identifying the track.

(b) Before taking size estimation, the performance correction factor must be obtained (section 22) and the calibration of the main gain must be checked. Both of these should be done during preparation for action and before coming on watch.

(c) Performance should be checked, also, every hour while on watch and the result entered in the performance correction log.

Drill

123. *(a)* Radar 1 receives and relays orders to operators: "............ SIZE ESTIMATION..............".

(b) Radar 2/3 accurately track the target echo and when on:—

(i) Radar 2 reports "ON RANGE..............YARDS".

(ii) Radar 3 reports "ON BEARING.................. DEGREES..............MINUTES...............".

(c) Radar 1 records range and bearings on the vessel size estimation log (Appendix "D" (v)) starts the stopwatch and after 20 seconds orders "READ".

(d) Radar 2 measures and reports signal strength as follows:—

- (i) Turns down main gain until maximum beat comes just above the datum line.
- (ii) Notes the maximum beat registered against the vertical db scale.
- (iii) On the order "READ" from Radar 1, mentally adds this to the setting of the main gain and reports this figure only.

(e) Radar 1 records the figure reported by 2, and after 20 seconds, orders "READ" again.

(f) The drill in *(d)* and *(e)* is repeated a total of five times.

(g) After the fifth reading Radar 2/3 report range/bearing which is recorded by 1.

(h) Radar 1 finds the vessel size as follows:—

- (i) Finds the mean range.
- (ii) Finds the mean signal strength and adds to it the performance correction factor.
- (iii) Plots the corrected signal strength on the signal strength-range curves chart, for the correct height of battery (Performance Chcks and Estimations of Vessels Size on CDX No. 2. Mk. 1 Radar 1946 Figure 6.)

(j) When four or more consistent plots are obtained, Radar 1 will report the size estimation in the following manner:—

Track letter, No. of vessels, vessel size, eg:

"SKUNK A, ONE, SIZE ESTIMATION SMALL".

(k) Borderline cases must be reported as such using the word "OR" and not the word "TO". eg: "SIZE ESTIMATION MEDIUM OR LARGE".

Note: No estimation will be reported:—

If plots are varying by width of more than $1\frac{1}{2}$ classes.

On plots taken when the target is in beam on (inclination approximately 090).

Until signal strength plots follow normal curves.

APPENDIX "A"

CALIBRATION OF MAIN GAIN CONTROL DIAL

Unit for measuring signal strength

General

1. The signal seen on the display tube is produced by a voltage change due to the radar echo. The stronger the echo, the greater the voltage change and the higher the signal on the tube. For normal deflections (1-3 cm.) it appears that the voltage and the height of the signal are directly proportional to each other. In this case the receiver amplification is said to be linear, but a few sets are not linear for signals of this height.

2. When a set is working with high amplification, the display tube shows innumerable small voltage deflections spoken of as noise or grass, the height of which is known as noise level, and the strength of a signal is conveniently measured by its height in relation to this noise level. It is not generally appreciated that the deflection which produces an echo on the tube has added to it the voltage from the noise. As a result, the echo popularly known as 2 to 1 is not due to a signal voltage twice that of the noise, but the echo together with the noise is equal to twice the noise, ie., the true signal—to noise ratio is really 1 to 1. Similarly the so called 3 to 1 echo is really 2 to 1, the 10 to 1 is really 9 to 1, while the so-called 3 to 2 echo is really ½ to 1, and so on. The error due to adding in the noise to the height of the echo makes much less difference in the case of large, rather than small signals. This point is important, and is referred to in greater detail in para. 10. Throughout this treatise all ratios are true unless specifically mentioned as apparent.

3. As already mentioned, it is necessary when checking performance to measure signal-strength more accurately than by gauging the signal-to -noise ratio by eye. Also we require to know the strength of echoes which are up to saturation (that is, up to the maximum height obtainable by signals on the CRT) with the gain control at normal operation level. The most convenient method of measuring signal-strength is to adjust the gain control so that the echo comes up to a line drawn across the face of the display tube, and to record in suitable units the amount by which the gain has been adjusted to do this.

4. The unit selected for this purpose is decibels above noise. The bel, named after Alexander Graham Bell, the inventor of the telephone was originally introduced by telephone engineers as a means of comparing power ratios. The logarithms of the ratio was used. There are 10 decibels in one bel, so that a power ratio in decibels is the value of 10 log.

$$\frac{\text{signal power}}{\text{noise power.}}$$

As used on radar sets, this gives an alternative method of measuring the signal-to-noise ratio since in decibels:—

$$10 \text{ Log } \frac{\text{signal power}}{\text{noise voltage}} = 10 \text{ Log } \frac{\text{signal voltage}^2}{\text{noise voltage}^2}$$

(Since power is proportional to voltage squared)

$$20 \text{ Log. } \frac{\text{signal voltage}}{\text{noise voltage}} = 20 \text{ Log. signal/noise ratio}$$

5. The following tables gives some commonly used values of decibels in terms of signal-to-noise. Both the "true" and the "apparent" signal-to-noise ratios are given:

TABLE 1

Decibels	True S/N Ratio	Apparent S/N Ratio	Power Ratio
0	1/1	2/1	1/1
5	1·8/1	2·8/1	3/1
10	3·2/1	4·2/1	10/1
15	5·6/1	6·6/1	32/1
20	10/1	11/1	100/1
25	18/1	19/1	300/1
30	32/1	33/1	1,000/1
40	100/1	101/1	10,000/1
50	320/1	321/1	100,000/1
60	1,000/1	1,000/1	1,000,000/1

Apparent S/N ratio	True S/N Ratio	Decibels
2/1	1/1	0
3/1	2/1	6
4/1	3/1	10
5/1	4/1	12
6/1	5/1	14
9/1	8/1	18
11/1	10/1	20
3/2	½/1	−6
5/4	¼/1	−12

Preparing the CRT and marking the Gain Scale

6. To measure the amount by which the gain control is adjusted, it is calibrated in steps of 5 decibels. To do this, use is made of the fact that if a

signal is reduced in height from 1·8 cm. to 1 cm., it has been reduced by 5 decibels (see Table 1). The procedure is therefore as follows:—

Preparation for CRT

(a) Check that the output voltage of the regulated 300 volt power unit as at the normal level.

(b) Check time base at working position on the CRT screen. Adjust with vertical and horizontal shifts if necessary and mark the position of each end of the trace with an ink spot.

(c) Draw a datum line in ink 1 cm. above the trace and a 5 db. line 1·8 cm. above the trace. Both lines to be drawn right across the face of the CRT.

(d) Prepare a vertical transparent scale marked off in 2 db. graduations from 0 to 12 db. To make this scale, mark off from a zero point, 2 db. graduations at the following distances:—

Graduation	Distance from zero mark
0 db.	1·0 cm Datum Line
2 “	1·25 “ “
4 “	1·6 “ “
6 “	2·0 “
8 “	2·5 “ “
10 “	3·2 “ “
12 “	4·0 “ “

(e) Fix the scale to the side of the CRT face so that the zero mark is on the trace, the 0 db. mark is on the *datum line* and the 5 db. line comes between the 4 and 6 db. marks as shown in Figure 5.

(f) Another satisfactory method of preparing the CRT is to prepare a thin piece of celluloid 6″ x 6″ by etching on it a zero mark line, datum line, 5 db. line and vertical db. scale at the correct intervals as given in *(d)*. This celluloid mask is then fitted directly over the face of the CRT and the trace, adjusted to coincide with the zero mark line.

Setting up the pre-set gain

7. *(a)* Rotate the aerial until a 2 to 1 signal is formed.

(b) Turn the hand gain control fully up.

(c) Adjust the pre-set gain control until the extreme tip of the echo just beats up to the 6 db. mark on the vertical scale (6 db. = 2 to 1 signal-to-noise ratio).

(d) This adjustment should fix the noise level at the 0 db. or datum line.

Calibration of the gain control

8. *(a)* Turn gain control fully up and mark this position.

(b) Rotate the aerial until a steady PE is found, the tip of which just reaches the 5 db. line.

(c) Turn down the gain control until this PE just reaches the datum line. Mark this position of the pointer with a dot and number 5.

(d) Rotate the aerial again until a steady PE just comes up to the 5 db. line.

(e) Turn down the gain until the PE just reaches the datum line. Mark this position of the pointer with a dot and number 10.

(f) Repeat this procedure until the gain control is fully down.

(g) From 25 db. onwards the pointer settings should be marked with a line.

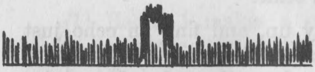
(h) Any alteration of the pre-set gain alters this calibration.

Correcting for noise

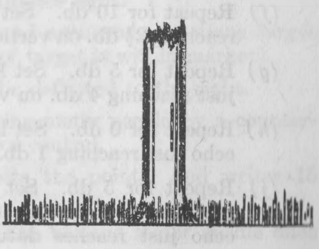
9. The object of the calibration is to mark the position of the gain control at which echoes of 0 db. above noise, 5 db., 15 db., above noise etc., just comes up to the datum line. The above procedure has not quite achieved this result, since the echo used in the calibration has some noise on the top of it, and the amount of this noise varies with the setting of the gain control. It is, therefore, the height of the signal-plus-noise and not of the signal alone, which has been reduced in 5 db. steps. The calibration therefore must be corrected so that it reads in terms of true signal-above-noise.

10. After the gain has been reduced by four steps of 5 db. so little noise is left on top of the echo that its apparent height (with noise on top) is very little greater than its true height without the noise. Hence no correction is needed for the steps marked 25 and over, and these can be taken as decibels above noise, but below the 25 db. mark the effect of the noise is appreciable and it is greater the higher that the gain is turned, and the smaller the height of the echo in proportion to the height of the noise. The relative importance of correcting for noise with small and large signal is illustrated below:—

Small Signal



Large Signal.



11. The uncorrected scale is in terms of signal-plus-noise. The 6 db. position on this scale corresponds to a signal-plus-noise to noise ratio of 2 to 1. As discussed earlier, this is really a true signal-to-noise ratio of 1 to 1, and 1 to 1 signal is 0 db. above noise (see Table 1), so the correct zero db. position is that of 6 on the uncorrected scale. Similarly the position of 9 on the uncorrected scale corresponds to an apparent signal-plus-noise to noise ratio of 2·8 to 1. This is a true signal-to-noise ratio of 1·8 to 1 which corresponds to 5 db. above noise, hence the true 5 db. position is that of 9 on the uncorrected scale and should be marked accordingly. By a similar calculation the true 10 db. position is at $12\frac{1}{2}$ on the uncorrected scale, the true 15 db. is at $16\frac{3}{4}$ and the true 20 db. is at 21. As already noted, the correction for noise gradually gets smaller, the larger the echo, and above 20 db. it can be neglected altogether.

TABLE 2

Correction of db. Steps for Noise

12. (*a*)	Uncorrected positions using 20 log (signal-plus-noise)/noise.	6 db.	9 db.	12½ db.	16½ db.	21 db.
(*b*)	Corresponding (signal plus noise) noise ratio	2/1	2·8/1	4·2/1	6·6/1	11/1
(*c*)	Corresponding true signal/noise ratio	1/1	1·8/1	3·2/1	5·6/1	10/1
(*d*)	20 log true signal/noise = corrected positions.	0 db.	5 db.	10 db.	15 db.	20 db.

13. A practical method of correcting the gain calibration for noise level is as follows:—

(*a*) Set the gain control pointer to the 20 db. mark.

(*b*) Rotate the aerial until a steady PE just reaching 1 db. on the vertical scale is found.

(*c*) Turn down gain until PE is at datum line.

(*d*) Mark this setting of the gain control pointer with a line and label 20. Rub out the old 20 but leave the dot for correcting the 5 db. calibration.

(*e*) Repeat for 15 db. Set hand gain control to uncorrected 15 mark and find an echo just reaching 1½ db. on vertical scale. Turn down again until echo just reaches datum line. Mark, and label this new position of the gain pointer 15.

(*f*) Repeat for 10 db. Set gain to uncorrected 10. Find an echo just reaching 2½ db. on vertical scale.

(*g*) Repeat for 5 db. Set hand gain to uncorrected 5 and find an echo just reaching 4 db. on vertical scale.

(*h*) Repeat for 0 db. Set hand gain back to uncorrected 5 and find an echo just reaching 1 db. on the vertical scale.

(*j*) Repeat for 5 db. Set hand gain fully up, and find an echo just reaching 3·8 db. on the vertical scale. Turn gain down until echo just reaches datum line and mark setting of gain pointer —5 db.

APPENDIX "B"

CALIBRATION OF BEARING ERROR DIAL

1. The bearing error dial will be calibrated by the radar detachment under the supervision of Radar 1 and with the assistance of the radar mechanic. The calibration will be checked each day during preparation for action. Before attempting calibration, Radar 1 will ensure that the radar mechanic has set up the integrator according to CAEMEI specifications.

2. Operators required for the calibrations are:—

Radar 1	Supervisor.
Radar 2	Range Operator.
Radar 3	Bearing Operator.

3. The best PE for the particular site should be selected. If no suitable PE is available (temporarily) a stationary vessel at long range will suffice. The operators then proceed as follows:—

(a) Radar 2 and 3 lay accurately on the selected target.

(b) Radar 3 notes bearing to the nearest minute.

(c) Radar 2 depresses the spotting switch and accurately positions the target in the error marker.

(d) Radar 3 centers bearing meter needle by means of bearing error control.

(e) Radar 1 draws a ½ inch line on the dial opposite position of pointer and marks this zero.

(f) Radar 2 releases spotting switch.

(g) Radar 3 lays radar off bearings 15 minutes right.

(h) Radar 2 depresses spotting switch and accurately positions target in error marker (making sure whole of target is within marker).

(j) The bearing meter needle will now be deflected to the right.

(k) Radar 3 accurately centers the bearing meter needle by a counter-clockwise rotation of the bearing error control.

(l) Radar 1 makes a small dot opposite the pointer and writes 15 opposite this mark.

(m) Radar 2 releases spotting switch. The bearing meter needle once more deflects to the right.

(n) Radar 3 relays on the target by centering the bearing meter needle and notes the exact bearing to the target (as read off radar bearing magslip dials to the nearest minute).

(o) The above procedure will be repeated for 30 minutes, 45 minutes and so on until a 2 degree right calibration has been obtained, and for 15 minutes, 30 minutes, 45 minutes and so on until a 2 degree left calibration has been obtained. The ¼ degree marks should be 1/8 inch lines and full degree marks ¼ inch lines.

(p) It may be necessary to decrease the sensitivity control on the integrator in order to obtain a calibration of 2 degrees on the bearing error dial.

APPENDIX "C"

CARE AND MAINTENANCE

Operators task

1. This procedure will be carried out daily, weekly, twice monthly and monthly by the operators under the supervision of Radar 1. The task table used will aid in keeping the work up-to-date in distributing the tasks over the month.

Operations room

2. *(a)* Empty ash trays.
   (b) Sweep floor, using sweeping compound.
   (c) Dust all racks with soft brush. Dust all ledges, projections, etc.
   (d) Clean racks with vacuum cleaner.
   (e) Examine fire extinguishers, to see that they are in good condition and readily accessible.

Stock

3. Count the 3 BX tubes, ensuring that the stock is complete.

Ground connections

4. Inspect the gound connections and clean if necessary. Ensure that all such connections are tight.

Telescope and Mounting

5. *(a)* Ensure that the mounting is securely fixed to the doghouse.
   (b) Clean the lens of the telescope externally with optical cloth.
   (c) Sight through the telescope on some object to ensure that the telescope is in good working order.

Bolting of Paraboloids

6. *(a)* Ensure that the paraboloids are secured on the mounting rings.
   (b) Inspect the clevis bolts, ensuring that they are tight and that the cotter pins are in place.

Rack No. 1. Fan

7. *(a)* Check that the motor is firmly bolted in the rack.
   (b) Start the motor and check that the fan blades do not scrape.
   (c) Check that the protective screen is held securely in place.

Telephone connections

8. *(a)* Inspect and clean outdoor telephone terminals on tower.
   (b) Plug in telephone and check by using.

Control knobs

9. Inspect control knobs and tighten set screws to secure any that are loose.

Conditions of paint

10. *(a)* Examine racks and all external painted parts for cracked and peeling paint and bare spots.
    (b) Sand all bare spots free of rust or peeling paint.
    (c) Paint all bare spots.

Door of station

11. *(a)* Inspect the door hinges to ensure that they operate smoothly, are securely mounted and not damaged.
    (b) Inspect the door locks and knobs.
    (c) Where necessary, check conditions of weather stripping.

Operator seats

12. Inspect the seats for mechanical defects and damage to upholstery.

Structure

13. *(a)* Check all bolted or welded joints in tower, rotating mechanism housing and doghouse for breaks or defects.
    (b) Check all fasteners and handles on openings in doghouse, tower and rotating mechanism housing.

Tarpaulin

14. Inspect the tarpaulin for dampness, mildew or tears.

Essential spares

15. *(a)* Check the essential spares against the list of essential spares noting any shortages.
    (b) Check that all spares are in good condition.
    (c) Indent immediately for replacements of all items where stock has become depleted by 50 per cent or more.
    (d) The stock of essential spares should never be allowed to become completely exhausted of any item. If such a condition should exist, immediate remedial action will be taken through normal channels.

APPENDIX "D" (i)

DATUM BOARD

(Example)

Battery							Date prepared
Datum	Description	Radar Bearing	Radar Range	Gun Bearing	Gun Range	No 2 CRT Time Base	Signal Strength in D.B.
No. 1	Buoy	040°47′	5435	041°04′	4970		35
No. 2	Lighthouse	097°25′	27640	099°12′	27015		28
No. 3	Small Island	243°27′	14310	246°14′	14270		40
Etc.							

APPENDIX "D" (ii)

FALL OF SHOT INDICATION AND RECORDING FORM

.................Battery...........Date

Salvo	Line Indication	Range Indication	Salvo	Line Indication	Range Indication

APPENDIX "D" (iii)

LOG FOR ROUTINE SWEEPING

..............Battery...............Date

Target No.	Time	Bearing	Range	Signal Strength	Estimation of Vessel Size

APPENDIX "D" (iv)

STANDARD PERFORMANCE FIGURE..........

CDX No. 2. MK 1.

PERFORMANCE CORRECTION LOG

TIME	SIGNAL STRENGTH READINGS OF SELECTED PE'S					MEAN in db.	PERFORMANCE CORRECTION FACTOR IN db
	No. 1 PE	No. 2 PE	No. 3 PE	No. 4 PE	No. 5 PE		

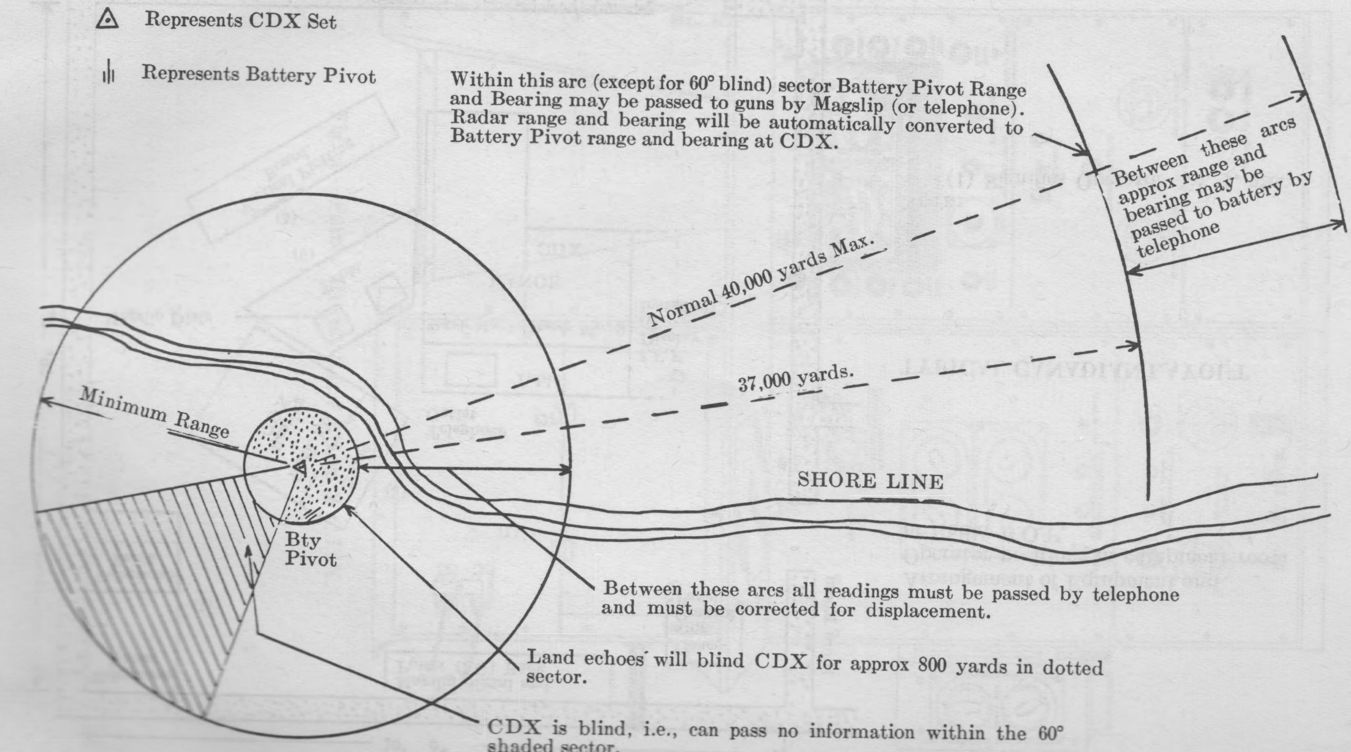
APPENDIX "D" (v)

CDX No. 2. MK 1

VESSEL SIZE ESTIMATION LOG

DATE	TIME	TRACK No.	BEARING	RANGE	MEAN RANGE	db READING								REMARKS eg. SIZE No. VESSELS, IDENT.
						1	2	3	4	5	Average	Correction	Total	

CDX COVERAGE



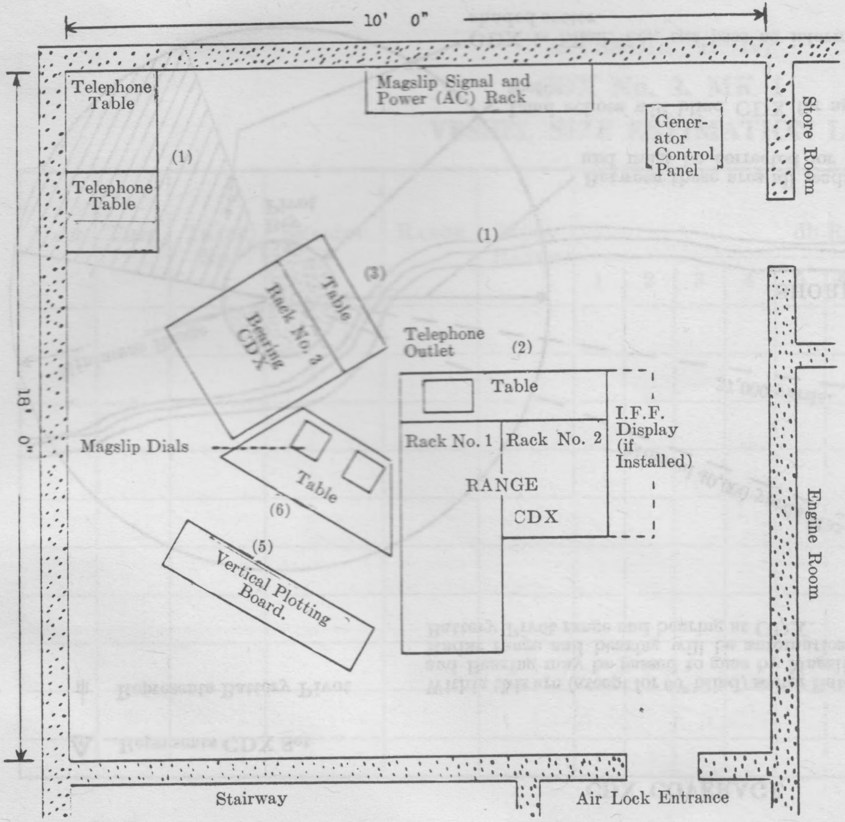
Within this arc (except for 60° blind) sector Battery Pivot Range and Bearing may be passed to guns by Magslip (or telephone). Radar range and bearing will be automatically converted to Battery Pivot range and bearing at CDX.

Between these arcs approx range and bearing may be passed to battery by telephone

Between these arcs all readings must be passed by telephone and must be corrected for displacement.

Land echoes will blind CDX for approx 800 yards in dotted sector.

CDX is blind, i.e., can pass no information within the 60° shaded sector.



Arrangement of Equipment and Operator positions in equipment room of Radar B.O.P.

TYPICAL CANADIAN LAYOUT

NOTE:
(1) Signifies Operator No. 1, etc.

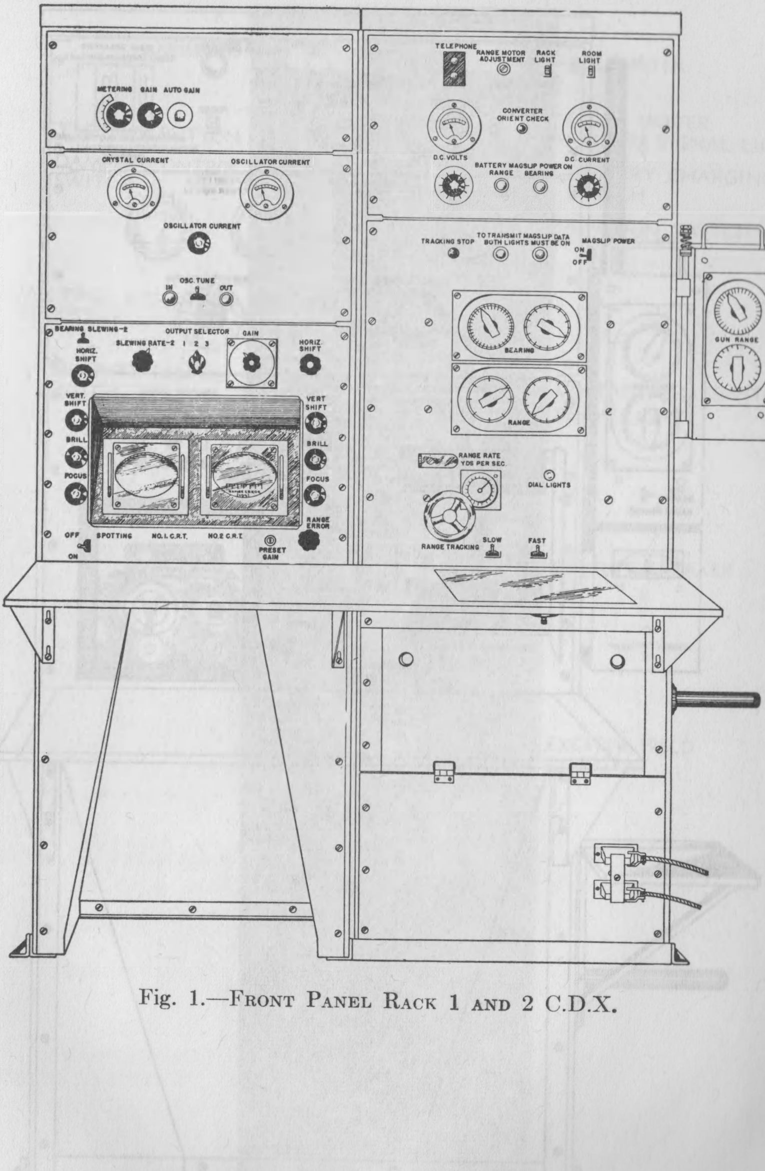


Fig. 1.—Front Panel Rack 1 and 2 C.D.X.

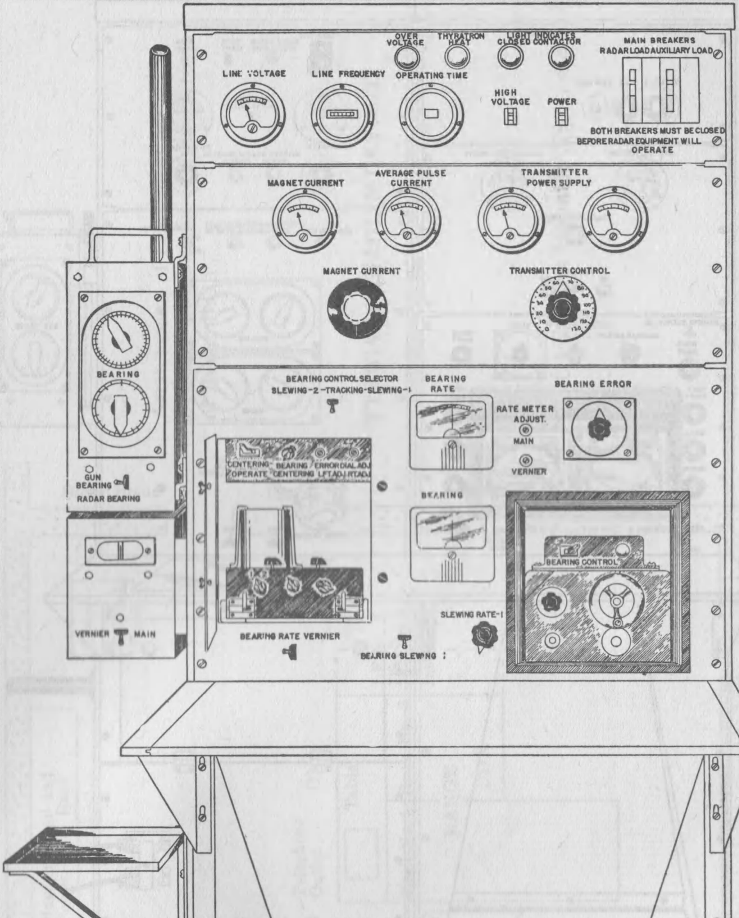


Fig. 2.—Front Panel Rack No. 3 C.D.X.

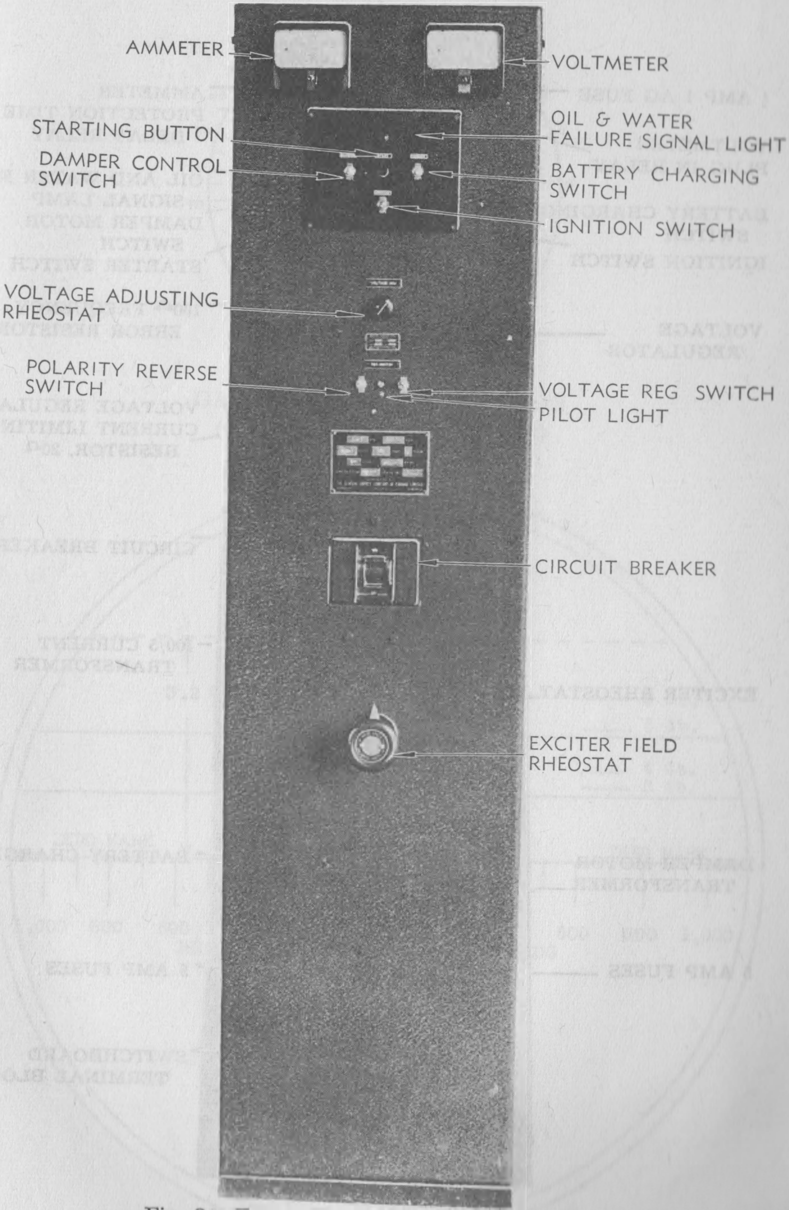


Fig. 3.—Front View of Control Panel

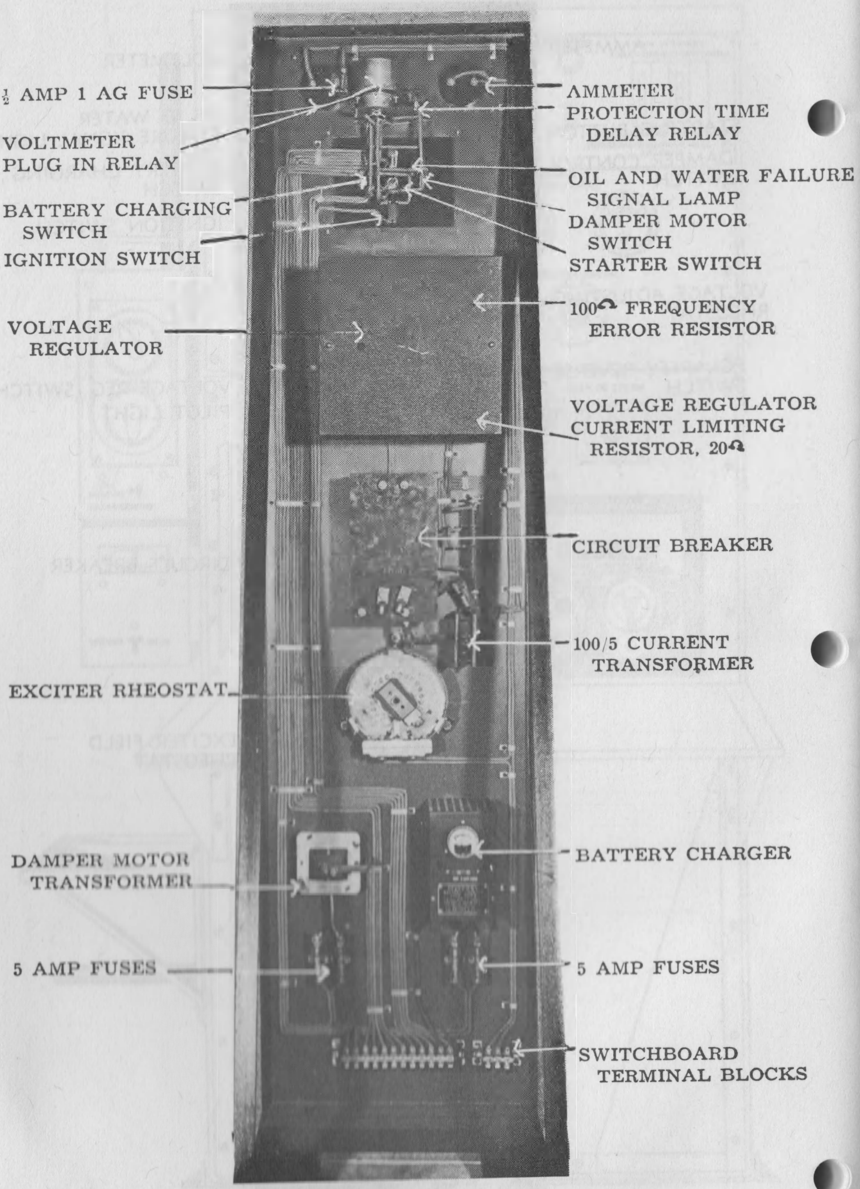
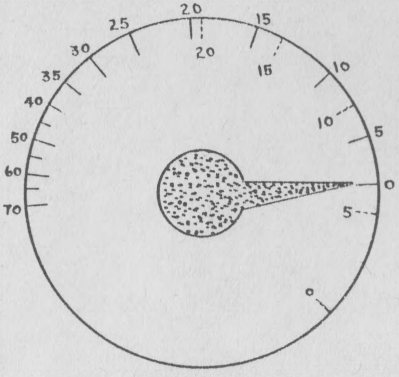
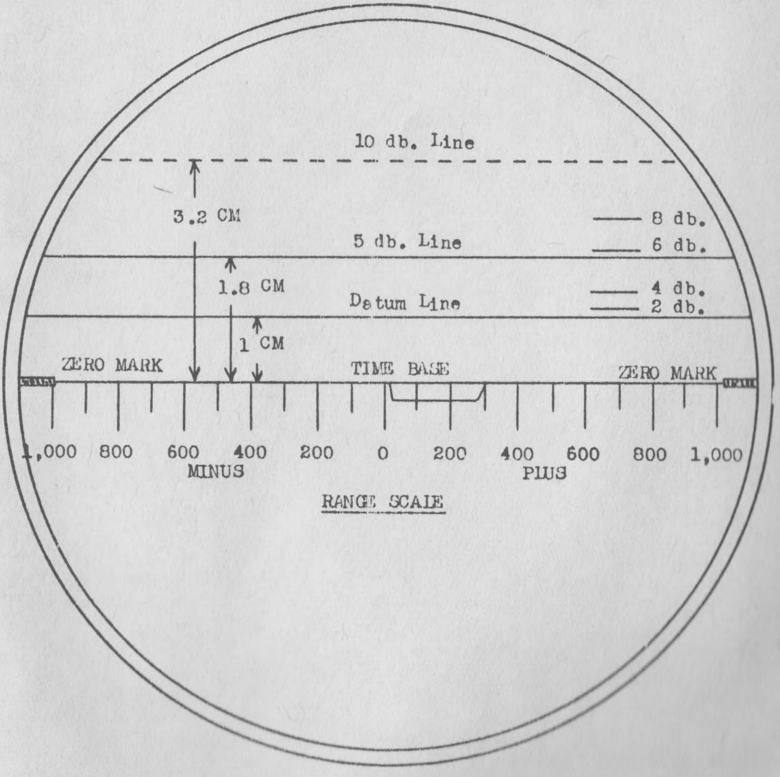


Fig. 4.—Rear View of Control Panel



GAIN CONTROL CALIBRATION
(uncorrected steps shown dotted)



No. 2 CRT